IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

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|---|---|---|
| THE GILLETTE COMPANY,<br><br>Plaintiff,<br><br>v.<br><br>DOLLAR SHAVE CLUB, INC., DORCO COMPANY LTD. and PACE SHAVE, INC.,<br><br>Defendants. | )<br>)<br>)<br>)<br>)<br>)<br>)<br>)<br>)<br>) | C.A. No. 15-1158-LPS<br><br>REDACTED:<br>PUBLIC VERSION |

**DEFENDANTS' OPENING CLAIM CONSTRUCTION BRIEF**


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Dated: March 1, 2017

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## I. INTRODUCTION

Defendants Dollar Shave Club, Inc., Dorco Company Ltd., and Pace Shave, Inc. (collectively, "Defendants") respectfully submit this Opening Claim Construction Brief in support of their proposed constructions for the three disputed terms of asserted U.S. Patent No. 6,684,513 ("the '513 patent").

Defendants' constructions reflect what one of ordinary skill in the art would understand the terms to mean when read in light of the intrinsic evidence and as confirmed by extrinsic evidence. By contrast, Plaintiff The Gillette Company ("Gillette") proposes broad constructions that are divorced from the intrinsic evidence, and contrary to Gillette's own admissions regarding the scope of the '513 patent claims, in an effort to manufacture infringement arguments. For example, despite repeatedly telling the Patent Office that the claimed "amorphous material" "exclude[s] crystalline material" in order to distinguish prior art, Gillette now contends that "amorphous material" can include crystalline structures. As another example, Gillette's overly broad construction of "overcoat layer" as simply a "layer" ignores the clear statements in the intrinsic record that the layer must be a separate layer that improves adhesion between the hard coating and outer layer. And as for the "doped with another element" term, Gillette's proposed construction that it means adding another element, no matter the amount or affect, ignores the specification's clear statement that the dopant is merely an "additive," that is, a small amount of a substance added to something else to alter certain properties. For the reasons discussed in detail below, Defendants respectfully request that their constructions be adopted.

## II. TECHNOLOGY OVERVIEW

The '513 patent is directed to "improvements to razors and razor blades," and in particular to coatings of a razor blade. D.I. 249, Ex. B at 1:3-4. For at least several decades, a razor blade has typically comprised a substrate upon which other coatings are deposited to

improve the strength, durability, comfort, and other key properties of the razor blade. *See* D.I. 249, Ex. D at 3:11-28; Ex. 1 at 1:12-33, 1:47-60. The makeup and function of coating layers have been known for decades. *See, e.g.*, D.I. 249, Ex. D at 1:59-2:11; Ex. 1 at 1:18-60.

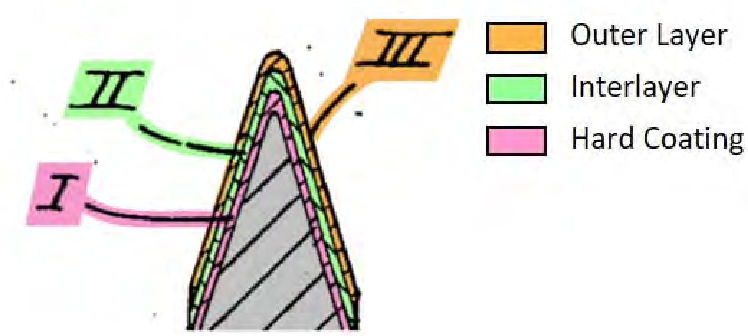
For example, to increase the hardness and corrosion resistance of the razor blades, the substrate is coated with a layer of material that is substantially harder than the substrate material. *See, e.g.*, Ex. 1 at 1:17-33; D.I. 249, Ex. D at 1:15-58, 14:37-50. Decades ago, materials such as corundum and ceramics were considered suitable hard coating materials. D.I. 249, Ex. D at 1:15-41. But such materials can be difficult to use. *Id.* By the mid-1990s, new synthetic materials with diamond-like properties, including elevated hardness and corrosion resistance, became available and known as suitable hard coating materials. Ex. 1 at 1:22-37. One of these materials was "diamond-like carbon" or "DLC," which exhibits many of the desirable properties of diamond, but is amorphous. *Id.*; *see also* D.I. 249, Ex. B at 1:9-14.

Coatings have also long been used to improve the comfort of razor blades when shaving. D.I. 249, Ex. D at 1:59-2:7. One approach that has been used for decades to improve comfort is to coat razor blades with an outer layer of a polymer called polytetrafluoroethylene (PTFE), also known as Teflon. D.I. 249, Ex. D at 1:67-2:3. PTFE is a lubricating material that reduces friction, thereby improving comfort during shaving. D.I. 249, Ex. B at 1:14-15. According to the Lane reference, "most razor blades produced today [in 1973] contain a coating of polytetrafluoroethylene (PTFE), which substance has provided an extremely low coefficient of friction…" D.I. 249, Ex. D at 1:59-2:12; *see also id.* at Cover (showing April 18, 1973 filing date).

Depending on the materials used, a hard coating and PTFE outer layer may by themselves provide an effective and durable razor blade. *See, e.g.*, Ex. 2 at 4:35-51; *see also* D.I.

249, Ex. B at 1:19-23 (incorporating ’975 patent by reference). However, in some cases additional layers have been used to support the functions of the hard coating and the PTFE outer layers. For example, in order for the razor blades to maintain durability and comfort, the hard coating must adhere sufficiently to the substrate and the outer layer must adhere sufficiently to the hard coating. *See, e.g.*, Ex. 1 at 1:26-33. Thus, razor blades have long included one or more adhesion layers, sometimes called “interlayer[s],” to improve bonding between the hard coating and substrate or between the hard coating and outer layer. *See, e.g.*, Ex. 1 at 1:49-55; D.I. 249, Ex. D at 6:11-18. It has long been known that certain chromium-based materials can promote adhesion, including adhesion to a PTFE outer layer and to DLC. D.I. 249, Ex. D at 6:14-16; *id.* at Ex. B at 1:15-19.

Figure 5 from the Lane reference (highlighted; key added) shows an exemplary razor blade including the substrate, hard coating, adhesive interlayer, and PTFE outer layer:




## III. LEGAL STANDARDS

“It is a ‘bedrock principle’ of patent law that ‘the claims of a patent define the invention to which the patentee is entitled the right to exclude.’” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (*en banc*). “Claim terms are generally given their ordinary and customary meaning” as understood by a person of ordinary skill at the time of the invention, who reads the

claims "in the context of the entire patent, including the specification and prosecution history." *Computer Docking Station Corp. v. Dell, Inc.*, 519 F.3d 1366, 1373-74 (Fed. Cir. 2008).

The specification "is always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term." *Phillips*, 415 F.3d at 1315 (citation omitted). In order for the court to determine the "scope of the actual invention," it must prevent "divorcing the claim language from the specification." *See id.* at 1323-24. "'[U]ltimately, the interpretation to be given a term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to envelop with the claim.' It is therefore entirely proper to consider the functions of an invention in seeking to determine the meaning of particular claim language." *Medrad, Inc. v. MRI Devices Corp.*, 401 F.3d 1313, 1319 (Fed. Cir. 2005). "The use of comparative and functional language to construe and explain a claim term is not improper. A description of what a component does may add clarity and understanding to the meaning and scope of the claim." *Funai Elec. Co. v. Daewoo Elecs. Corp.*, 616 F.3d 1357, 1366 (Fed. Cir. 2010).

The patent's prosecution history is important intrinsic evidence that the court "should also consider." *Phillips*, 415 F.3d at 1317 (citation omitted). "[T]he prosecution history can often inform the meaning of the claim language by demonstrating how the inventor understood the invention and whether the inventor limited the invention in the course of prosecution, making the claim scope narrower than it would otherwise be." *Id.* For instance, a patentee limits the meaning of the claims when they "clearly characteriz[e] the invention in a way to try to overcome rejections based on prior art." *Computer Docking Station Corp.*, 519 F.3d at 1374. The prosecution history of foreign counterparts to the patent-at-issue is relevant to claim construction as well. *See Starhome GmbH v. AT & T Mobility LLC*, 743 F.3d 849, 858 (Fed. Cir.

2014) (considering the patentee's statements before the EPO as "yet another indication" supporting the court's construction).

In addition, a court may rely on extrinsic evidence. *Phillips*, 415 F.3d at 1317 (citation omitted). Technical dictionaries can be especially useful to "better understand the underlying technology and the way in which one of skill in the art might use the claim terms." *Id.* at 1318 (citation omitted). In addition, expert testimony may "ensure that the court's understanding of the technical aspects of the patent is consistent with that of a person of skill in the art." *Id.*

## IV. '513 PATENT OVERVIEW

### A. Specification

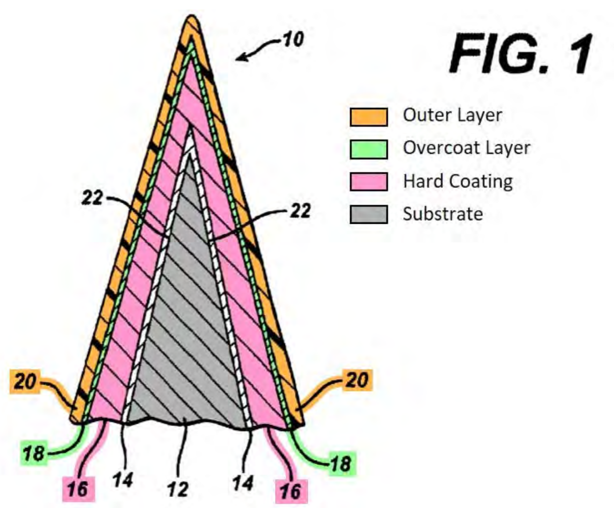
The '513 patent generally relates to coating technology and, more specifically, coating a razor blade. The '513 patent does not claim a new material for a coating layer. Rather, it purports to claim a new combination of three well-known and extensively used coating layers.

As the '513 patent acknowledges, hard coatings "are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used." D.I. 249, Ex. B at 1:9-14. It also identifies some of the known hard coating materials, including "diamond-like carbon-(DLC) material, nitrides, [and] carbides." *Id.* The '513 patent also admits that outer layers "can be used to provide friction reduction," and identifies "[p]olytetrafluoroethylene (PTFE)," as one known type of outer layer material. *Id.* at 1:14-15. The '513 patent further concedes that layers of "chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC." *Id.* at 1:16-19.

The '513 patent criticizes the prior art, however, for not having a separate binding layer between a carbon-containing amorphous hard coating (such as DLC), and PTFE outer coating layers. The specification contends that "the ultimate tip of the [razor blade] edges having hard

coatings and [PTFE] outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance." *Id.* at 1:24-28. The '513 patent purports to solve this problem by providing "an overcoat layer of a chromium containing material" between the hard coating and outer layers. *Id.* at 1:31-36. The '513 patent states that the advantage of the alleged invention is that the "chromium containing overcoat layer provides improved adhesion of the [PTFE] outer layer to the hard coating layer." *Id.* at 2:14-16.

Figure 1 of the '513 patent (annotated below) shows a cross-section of the alleged invention. *Id.* at 2:29-30. As shown, the razor blade includes four coating layers formed over substrate (12), namely, the interlayer (14), hard coating layer (16), overcoat layer (18), and outer layer (20). *Id.* at 2:37-45.




### B. Prosecution History

As originally-filed, the applicants claimed a razor blade with three layers: (1) a "layer of hard coating," (2) "an overcoat layer of chromium containing material" on the hard coating layer, and (3) an "outer layer of [PTFE] coating over" the overcoat layer. *See* D.I. 249, Ex. C at GILLETTE-DSC-0220517. The Examiner repeatedly rejected the claims as anticipated by the

prior art patent Lane, and as obvious in combination with other prior art references, including Hahn. D.I. 249, Ex. C at GILLETTE-DSC-0220703-05, 0220777-78, 0220817. In an attempt to overcome those rejections, the applicants did not dispute that Lane disclosed all three limitations. *See, e.g.*, *id*. at GILLETTE-DSC-0220811, 0220827, 0220845. Rather, applicants initially amended the claims to limit the hard coating layer to being "made of amorphous material," which they explained means the layer "exclude[s] crystalline material." *See id*. at GILLETTE-DSC-0220769, 0220771. After the Examiner again rejected the claims because Lane discloses the amorphous material glass, the applicants further amended the hard coating layer to be made of "amorphous material containing carbon" in order to distinguish Lane. *Id.* at GILLETTE-DSC-0220824, 0220838.

But the Examiner had also rejected the claims as obvious in light of Hahn in combination with Lane. D.I. 249, Ex. C at GILLETTE-DSC-0220816-820. In response, the applicants admitted that, as disclosed in Hahn, carbon-containing "amorphous [hard coat] materials have been used extensively with a telomer (PTFE) outer coating." *Id.* at GILLETTE-DSC-0220826. The applicants argued it would not be obvious to add the "adhesion promoting layer II containing chromium" from Lane because Hahn allegedly teaches "that a PTFE layer should be deposited directly on the amorphous hard coat carbon layer," and "thus teaches away from the invention." *Id.* at GILLETTE-DSC-0220827. Thus, the applicants distinguish Hahn as missing the crucial overcoat layer, which allegedly provided unexpected results. *Id.* The Examiner then allowed the claims. Ex. 12 at GILLETTE-DSC-0220848.

**C. Claims**

Gillette asserts twenty-one claims, including the five independent claims. Claim 1 is representative:

1. A razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

[1a] a layer of hard coating on said cutting edge, said hard coating being made of amorphous material containing carbon,

[1b] an overcoat layer of a chromium containing material on said layer of hard coating, and

[1c] an outer layer of polytetrafluoroethylene coating over said overcoat layer.

## V. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art ("POSA") would have at least an undergraduate degree in chemistry, physics, materials science, or an equivalent subject, with a minimum of three years of academic or work experience in coating technology; or at least a Master's degree in chemistry, physics, materials science, or an equivalent subject, with a minimum of one year of academic or work experience in coating technology. Declaration of Michael Watts in Support of Defendants' Opening Claim Construction Brief ("Watts Decl.") ¶ 12.

## VI. CLAIM CONSTRUCTIONS

### A. "Overcoat Layer of a Chromium Containing Material" (Claims 1, 20, 24, 28, 35)

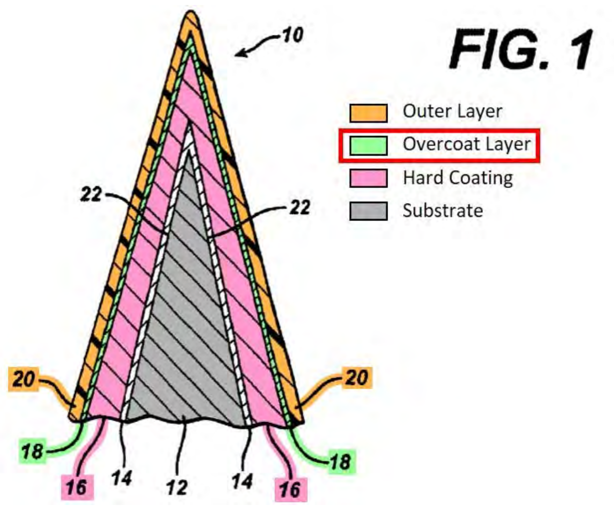
| Claim Term | Plaintiff's Proposed Construction | Defendants' Proposed Construction |
|---|---|---|
| overcoat layer of a chromium containing material | No construction is needed.<br>To the extent the Court believes a construction is necessary, Plaintiff will propose the ordinary meaning of the term as "a layer of chromium containing material on top of the layer of [hard coating]" (for claims 1, 20, 24] / [hard carbon containing material] (for claims 28, 35)" | Intermediate layer of chromium containing material that improves adhesion to the layer of [hard coating (for claims 1, 20, 24) /hard carbon containing material (for claims 28, 35)] |

The parties dispute whether the term "overcoat layer of a chromium containing material" should be construed as an intermediate layer and whether it must improve adhesion. Defendants'

construction comes directly from the intrinsic evidence and Gillette's own admissions in this litigation. On the other hand, Gillette's proposal seeks to improperly broaden the scope of the term to read on any chromium layer, regardless of whether it improves binding. Gillette is forced to do so because the accused products [redacted]

"Overcoat layer" is not a term of art that has a plain and ordinary meaning. Rather, as the intrinsic record confirms, Gillette used the term to refer to an adhesive interlayer, a separate and distinct layer that improves binding between the hard coat and outer layer. *Indacon, Inc. v. Facebook, Inc.*, 824 F.3d 1352, 1356-57 (Fed. Cir. 2016) (limiting the construction of "link" claim terms, which had no plain meaning in the art, to the disclosure in the specification); *Goldenberg v. Cytogen, Inc.*, 373 F.3d 1158, 1164 (Fed. Cir. 2004) ("Where a claim term has no ordinary and customary meaning, a court must resort to the remaining intrinsic evidence—the written description and the prosecution history—to obtain the meaning of that term."). For example, every independent claim requires that the "overcoat layer" be "on" the hard coating layer, and that the outer layer be "over" the overcoat layer—*i.e.* that the three layers be separate and that the "overcoat" be between the other two. D.I. 249, Ex. B at claims 1, 20, 24, 28, and 35. Further, every independent claim requires that the "overcoat layer" be of a "chromium containing material," *see id.*, confirming the role of this layer as promoting adhesion. *See* D.I. 249, Ex. D at 6:14-16 ("Rather immense statistical evidence has indicated a superior degree of performance by the use of preferably chromium or some chromium alloy [adhesive] coatings.")

The specification, such as Figure 1, confirms that the overcoat layer is a separate and intermediate layer between the hard coating and outer layers:




D.I. 249, Ex. B at Fig. 1 (colors and key added); *see also id.* at 2:37-39 (identifying "overcoat layer 18" in Fig. 1). The rest of the specification consistently and repeatedly describes the invention as an overcoat layer that is ***separate from and between*** the hard coat and outer layers. *Id.* at Abstract, 1:32-37 (substrate, hard coating, overcoat, outer layer); 1:38-44 (same); 1:45-60 (substrate, interlayer, hard coating, overcoat, outer layer); 1:61-66 (substrate, hard coating, overcoat, outer layer); 2:37-3:48 (substrate, interlayer, hard coating, overcoat, outer layer).

The specification also consistently describes the overcoat layer as improving binding. As an example, the Summary of the Invention explains that the key advantage of the chromium containing overcoat layer is that it improves adhesion: "[t]he use of a chromium containing overcoat layer provides ***improved adhesion*** of the [PTFE] outer layer to the hard coating layer."[1] D.I. 249, Ex. B at 2:14-16; *see also id.* at 3:5-8 ("Overcoat layer 18 is used to reduce the tip rounding of the hard coated edge and ***to facilitate bonding*** of the outer layer to the hard coating while still maintaining the benefits of both."). The '513 patent credits this improved adhesion as allowing the three layers to work better together to provide an improved shave. *Id.* at 2:14-22; Watts Decl. ¶ 20.

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[1] All emphasis has been added unless otherwise indicated.

Indeed, Gillette has admitted twice in this case that the "invention" requires that the overcoat "provides improved adhesion."

> 28. The invention of the '513 Patent is advantageous because the use of a chromium containing overcoat layer provides improved adhesion of the polytetrafluoroethylene outer layer. The razor blade has improved edge strength provided by the hard coating and has reduced tip rounding with repeated shaves. Reduced tip rounding minimizes any increase in cutting force thereby maintaining excellent shaving performance. The invention provides the razor blade with excellent shaving characteristics from the first shave onwards, and promotes durability.

D.I. 98 (First Amended Complaint) at ¶ 28 (annotations added); D.I. 1 at ¶ 17 (same).

The prosecution history supports Defendants' construction. First, an original drawing of Figure 1 of the '513 patent again shows that the overcoat layer is "for facilitating bonding":

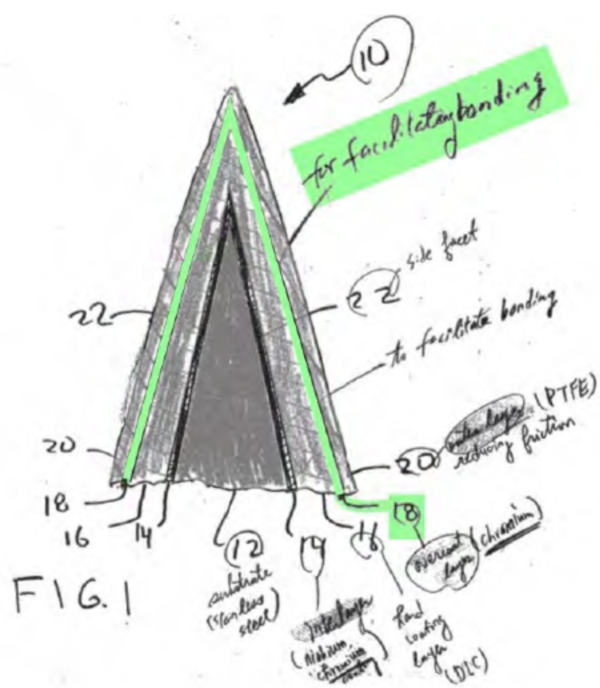


FIG. 1

Ex. 13 at 19 (green annotation added).[2] Second, in response to rejections over the Lane reference, applicants conceded that Lane discloses a hard coat layer I, "***an adhesion promoting layer II containing chromium***, and a PTFE layer III." *See, e.g.*, D.I. 249, Ex. C at GILLETTE-DSC-0220811. Applicants did not and could not deny that the "adhesion promoting layer II" is the claimed overcoat layer (or that the PTFE layer III is the claimed outer layer). Rather, after amending the claims, they went on to distinguish Lane based on the type of hard coat material disclosed. *Id.* at GILLETTE-DSC-0220811-812. Third, both the Examiner and the applicants recognized that the only layer missing from the Hahn reference is the claimed overcoat layer. While Examiner contended it was obvious to modify Hahn to include the overcoat layer between the hard coat and PTFE outer layer, applicant distinguished Hahn by arguing that it describes putting the PTFE layer directly on top of the hard coat and "thus teach[es] away from any use of an ***intermediate layer as in Lane***." *Id.* at GILLETTE-DSC-0220812; *see also id.* at GILLETTE-DSC-0220811 (arguing that Hahn's two layers "teaches the ***opposite of using a layer between*** the PTFE and amorphous hard coat layer"); Ex. 12 at GILLETTE-DSC-0220772 (same). In short, in discussing their alleged invention and distinguishing prior art, applicants expressly and repeatedly made clear that the overcoat layer is an "adhesion promoting" "intermediate layer" between the hard coat and outer layers. Watts Decl. ¶¶ 21-23; *Indacon, Inc.*, 824 F.3d at 1358 (recognizing that "the interested public has a right to rely on the inventor's statements made during prosecution" and finding that the prosecution history supported the limited construction of the "link" terms suggested by the specification); *see also Inpro II Licensing, S.A.R.L. v. T-Mobile USA, Inc.*, 450 F.3d 1350, 1354-55 (Fed. Cir. 2006) (noting that the "specification emphasizes

[2] Exhibit 13 is a part of the file history for the '513 patent and Defendants believe that it accurately represents the application originally submitted by Gillette to the U.S. Patent Office.

the importance of a [particular structure] in solving the problems" of the prior art and holding that the claims cannot "enlarge what is patented beyond what the inventor has described as the invention").

The extrinsic evidence also supports Defendants' construction. For example, during prosecution of the Japanese counterpart to the '513 patent, the same applicants, in trying to distinguish prior art, described the "concept of their invention" as "interposing a chromium containing coating between the coating containing diamond-like carbon (DLC) [hard coating] and the lubricious polymer coating of PTFE [outer layer] ***to improve the adhesion between*** the coating containing diamond-like carbon (DLC) and the lubricious polymer coating of PTFE and maintain the razor properties." Ex. 3 at PACE-037217; *see also id.* at PACE-037216 (stating that the chromium overcoat layer "improves the adhesion of the outer [PTFE] layer to the hard coating layer"); Watts Decl. ¶ 24. This statement was "made in an official proceeding in which the patentee[s] had every incentive to exercise care in characterizing the scope of its invention." *Microsoft Corp. v. Multi-Tech Sys., Inc.*, 357 F.3d 1340, 1350 (Fed. Cir. 2004) (finding statements in related, later prosecuted U.S. patent informs the meaning of earlier issued claims, stating "we take the patentee at its word and will not construe the scope" of the claims "more broadly than the patentee itself clearly envisioned"); *see also Starhome GmbH,* 743 F.3d at 858 (considering the patentee's statements before the EPO as "yet another indication" supporting the court's construction).

Moreover, in a later-filed patent application also assigned to Gillette, four of the inventors of the '513 patent tried to claim a two-layer razor blade—like the accused products—that has a PTFE outer layer directly on a chromium containing hard coat layer where

"there is no overcoat layer."[3] Ex. 4 at PACE-037273. Tellingly, Gillette acknowledged that when the hard coat contains chromium, there is ***no need*** for an overcoat layer: "The [PTFE] layer adheres well to the chromium-doped DLC layer even though the [PTFE] was applied directly to the chromium-doped DLC layer as an aqueous dispersion. It is believed that the chromium dopant aids in the adhesion between the layers." *Id.* at PACE-037271. Indeed, the '513 inventors expressly stated that, "optionally," the overcoat layer of the '513 patent may be included. *Id.* at PACE-037269. In making these arguments, the '513 inventors reinforced to the public that hard coat layers with chromium are distinct from the '513 patent's overcoat layer, and the overcoat layer is superfluous when the hard coat has sufficient adhesive properties. Ex. 4 at PACE-037271 (incorporating by reference the overcoat layer discussion in "U.S.S.N. 09/515,421," which is the application that issued as the '513 patent); *id.* at PACE-037272 (stating that "the razor blade may include two or more hard carbon layers"); Watts Decl. ¶ 24.

Gillette proposes that the overcoat term not be construed, but if it is construed, that it should be construed broadly to cover any chromium layer regardless of whether it improves binding or not. These proposals should be rejected. As an initial matter, there is a clear dispute between the parties as to whether the overcoat layer requires improving binding between the other two layers. This dispute should be resolved now as the overcoat term impacts all asserted claims and the construction adopted by this Court could potentially dispose of the case on non-infringement grounds. *O2 Micro Intern. Ltd. v. Beyond Innovation Tech. Co., Ltd.*, 521 F.3d 1351, 1362 (Fed. Cir. 2008) ("When the parties present a fundamental dispute regarding the scope of a claim term, it is the court's duty to resolve it.").

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3 During prosecution, Gillette faced a restriction requirement at which point it elected to not pursue the "no overcoat layer" claims (*see* Ex. 4 at PACE-037357) and abandoned them.

With regard to Gillette's proposed construction, it is incorrect. First, Gillette's proposal ignores the intrinsic evidence—and Gillette's own admission—that requires the overcoat to be a separate layer that improves adhesion between two specific layers. Having repeatedly taken the position that improved adhesion is the primary function of the overcoat layer and the advantage of the "invention of the '513 Patent," the term should be construed with that limitation. *Virnetx, Inc. v. Cisco Sys., Inc.*, 767 F.3d 1308, 1317-19 (Fed. Cir. 2014) (construing "secure communications link" to require that it "provides … anonymity" because that limitation was described as "one of the primary inventive contributions of the patent").

Second, Gillette's construction in terms of location is redundant and unhelpful. For example, when read in the context of claim 1, it reads: "[a layer of chromium containing material on top of the layer of hard coating] on said layer of hard coating." Instead of repeating that the overcoat is on top of the hard coat, there should be no dispute that the intrinsic evidence describes the overcoat as, in part, an intermediate layer between the hard coat and outer layer. Instead, a proper construction would reflect the full scope of the term's meaning as it was defined by the inventors in the context of the '513 patent.

Because Gillette's proposed construction ignores the intrinsic and extrinsic evidence, it should be rejected.

### B. "Amorphous Material" (Claims 1, 20, 24)

| Claim Term | Plaintiff's Proposed Construction | Defendants' Proposed Construction |
|---|---|---|
| amorphous material | material lacking long-range crystalline order | material having no detectable crystal structures |

Defendants propose that "amorphous material" means a "material having no detectable crystal structures." The intrinsic and extrinsic evidence support this construction. Indeed, during

the prosecution history, Gillette repeatedly said that it added the "amorphous material" limitation to "exclude crystalline material." Now, however, Gillette seeks to improperly broaden the term to include all crystal structures short of "long-range" crystals. Having limited the claims to non-crystalline material, Gillette cannot now change the meaning in an attempt to establish infringement.

Asserted independent claims 1, 20, and 24 recite that the hard coating must be "made of amorphous material containing carbon." Gillette amended the claims during prosecution to include the "amorphous material" limitation to distinguish the Lane prior art reference. Specifically, the Examiner found that Lane discloses a hard coating, a chromium containing overcoat layer, and a PTFE outer layer and, therefore anticipated the then-pending and broader claims. D.I. 249, Ex. C at GILLETTE-DSC-0220703-708. In order to try to distinguish Lane, the applicants limited the hard coating to "amorphous material" and explained what that means: "The claims have been amended to recite that the hard coating is made of "amorphous material," and, ***so limited, exclude crystalline material***." D.I. 249, Ex. C at GILLETTE-DSC-0220771, 0220810, 0220826, 0220844; Watts Decl. ¶ 27. Applicants then argued that amorphous hard coatings are advantageous over crystalline hard coatings because they do not face the problems that can result from crystal growth. *See, e.g.,* D.I. 249, Ex. C at GILLETTE-DSC-0220771; *see also id*. at GILLETTE-DSC-00220811 ("As noted above, the use of an amorphous material is advantageous in the invention in terms of obtaining a desired tip geometry without the problems associated with crystalline hard coatings."); Watts Decl. ¶ 28. Applicants concluded their distinction of Lane by arguing, "Lane accordingly does not anticipate or render obvious the

independent claims, because it nowhere discloses or suggests a hard coating of an amorphous material." Ex. 12 at GILLETTE-DSC-0220772.[4]

These unambiguous statements regarding the scope of the disputed term are dispositive—"amorphous material" means non-crystalline and does not permit the inclusion of any crystals. *Biogen Idec, Inc. v. GlaxoSmithKline LLC*, 713 F.3d 1090, 1095 (Fed. Cir. 2013) ("[W]hen the patentee unequivocally and unambiguously disavows a certain meaning to obtain a patent, the doctrine of prosecution history disclaimer narrows the meaning of the claim consistent with the scope of the claim surrendered."). Having distinguished its alleged invention from Lane on the basis that amorphous material ***excludes crystalline material***, Gillette cannot now broaden the meaning of the term. *See Microsoft Corp.*, 357 F.3d at 1349 ("We cannot construe the claims to cover subject matter broader than that which the patentee itself regarded as comprising its inventions and represented to the PTO."); *Gillespie v. Dywidag Sys. Int'l, USA*, 501 F.3d 1285, 1291 (Fed. Cir. 2007) (limiting the construction of "outer surface" based on Gillespie's arguments during prosecution to distinguish prior art).

The sole discussion of amorphous materials in the '513 patent is consistent with Gillette's disclaimer. In discussing the amorphous material DLC, the specification expressly refers to the "Handbook of Physical Vapor Deposition (PVD) Processing." D.I. 249, Ex. B at 2:67-3:4. It states that, "[a]s described in the [PVD Handbook], DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure

---

4 The Examiner rejected the claims again finding Lane disclosed the amorphous material glass as a hard coating. D.I. 249, Ex. C at GILLETTE-DSC-0220820 (explaining that, contrary to applicants' arguments, Lane "states 'glass' (i.e., amorphous material) can be used."). Applicants again amended their claims to qualify the hard coating as requiring not only that it be amorphous, but that it contains carbon as well. *Id*. at GILLETTE-DSC-0220826 ("Independent claims 1, 21, and 25 have been amended to recite an amorphous material containing carbon.").

of diamond." *Id.*; Watts Decl. ¶ 29. The PVD Handbook itself, which was published in 1998, uses the same definition of "amorphous material" that Defendants propose, namely, that "[a]morphous materials are those that ***have no detectable crystal structure.***" D.I. 249, Ex. E at 487. Numerous dictionaries also consistently define "amorphous" as "lacking distinct crystalline structure," "noncrystalline," and "not having crystals." Ex. 5; Ex. 6; Ex. 7; Watts Decl. ¶ 30.

Gillette proposes a construction, however, that covers materials having ***some*** crystalline structure (*e.g.*, polycrystalline materials), so long as there are no "long range" crystalline structures. Gillette does so in order to try to fashion an infringement argument. But its proposal contradicts the plain meaning of the term and, more importantly, Gillette's clear and repeated representation to the Patent Office as to what "amorphous material" means, *i.e.*, non-crystalline. *See* Watts Decl. ¶¶ 31-32. Accordingly, its proposal should be rejected.

### C. "Doped with Another Element" (Claims 19, 23, 28, 35)

| Claim Term | Plaintiff's Proposed Construction | Defendants' Proposed Construction |
|---|---|---|
| carbon containing material, doped with another element | carbon containing material, with another element added | carbon containing material, whereby another element is introduced into the material in small amounts to modify certain properties of the material |
| wherein said hard coating is doped with another element | wherein the hard coating has another element added | wherein another element is introduced into the hard coating in small amounts to modify certain properties of the coating |

Defendants' proposed construction of "doped with another element" is based on the plain and ordinary meaning of the term, as confirmed by the intrinsic and extrinsic evidence. The '513 patent uses the term "doped with another element" and "additive" interchangeably, and it was well known that both dopants and additives were a small amount of a substance added to

something else to alter its properties. Gillette diverges from the plain meaning by arguing that it means ***any*** addition of another element, no matter the amount. Gillette is incorrect.

The specification supports Defendants' construction. In particular, the specification states, "The carbon containing materials can be ***doped with other elements***, such as tungsten, titanium or chromium by including ***these additives***, for example in the target during application by sputtering." D.I. 249, Ex. B at 2:58-61. In other words, the specification expressly equates "doped with another element" with "additive" by using the terms interchangeably. Tellingly, these terms had plain and ordinary meanings that concerned adding a small amount of an element to a material to affect the material's properties. *See, e.g.,* Ex. 8 ("dopant" means "an impurity added usu[ally] in minute amounts to a pure substance to alter its properties."); Ex. 9 ("dope" means "[t]o add impurities (called dopants) to a substance, usually a solid, in a controlled manner to cause the substance to have certain desired properties"); Ex. 10 ("additive" means "a substance added to another in small quantities to effect a desired change in properties"); Ex. 11 ("additive" means "a substance added in small amounts to something else to improve, strengthen, or otherwise alter it"); Watts Decl. ¶¶ 35-36.

Further, contrary to Gillette's construction, the specification makes clear that not every material that contains carbon and another added element is a "carbon containing material doped with another element." For example, the specification lists "carbides, (e.g., silicon carbide)" as examples of known hard coating materials. D.I. 249, Ex. B at 2:52-57 and at 1:9-14. All carbides contain carbon and thus they are carbon containing materials. Watts Decl. ¶ 38. Each carbide also contains another element besides carbon. Silicon carbide, for example, is a chemical compound made of silicon and carbon. *Id*. However, a person of ordinary skill would not consider silicon carbide to be a carbon containing material "doped with" silicon. *Id*. Rather,

silicon carbide is a well-known host material that could itself be doped with another element, such as with aluminum, boron or nitrogen atoms. *Id*.

The claims themselves are also consistent with the plain meaning that a dopant should only be introduced in small amounts. For example, claim 19, which depends from claim 1, requires that the hard coating of claim 1 be "doped with another element." D.I. 249, Ex. B at 4:50-51. Because claim 19 incorporates all the limitations of claim 1, the hard coating, even when doped with another element, must be amorphous. *See* 35 U.S.C. § 112, ¶ 4 ("A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers."). Thus, a person of ordinary skill would understand that dopant is introduced to the hard coating only in small amounts in order to maintain the amorphous characteristic of the coating. Watts Decl. ¶ 35.

In sum, because Gillette's construction seeks to impermissibly broaden the scope of the term to cover any added element—even silicon added to carbon—and any amount added, it should be rejected.

## VII. CONCLUSION

For the reasons set forth above, Defendants respectfully request that the Court adopt each of Defendants' proposed constructions.

Respectfully submitted,


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Dated: March 1 2017

## CERTIFICATE OF SERVICE

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# Exhibit 1

US005295305A

# United States Patent [19]

**Hahn et al.**

[11] **Patent Number: 5,295,305**

[45] **Date of Patent: Mar. 22, 1994**

[54] **RAZOR BLADE TECHNOLOGY**


[75] Inventors: **Steve S. Hahn**, Wellesley Hills; **John Madeira**, Assonet, both of Mass.

[73] Assignee: **The Gillette Company**, Boston, Mass.



[21] Appl. No.: **8,396**

[22] Filed: **Jan. 25, 1993**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 835,251, Feb. 13, 1992, abandoned.

[51] **Int. Cl.**[5] ........................ **B26B 21/00**; B26B 21/54

[52] **U.S. Cl.** ........................ **30/50**; 30/346.53; 30/346.55

[58] **Field of Search** ........... 30/50, 346, 346.5, 346.53, 30/346.54, 346.55, 346.58, 346.59; 202/192.1



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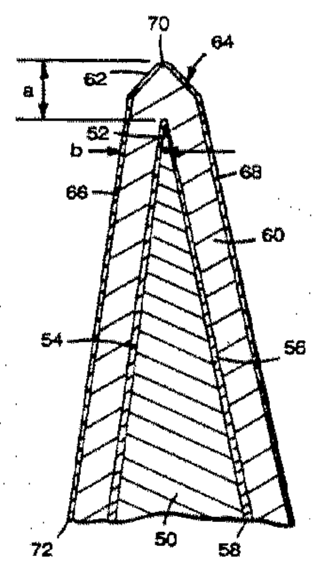
[57] **ABSTRACT**


A razor blade includes a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, nickel, niobium, and niobium-molybdenum alloy and alloys of such materials on the tip and flanks of the wedge-shaped edge, the thickness of the interlayer preferably being in the range of about 50–500 angstroms, and a layer of diamond or diamond-like carbon material on the interlayer that preferably has a thickness of about two thousand angstroms and that defines a tip radius of less than about 1000 angstroms.


**24 Claims, 1 Drawing Sheet**

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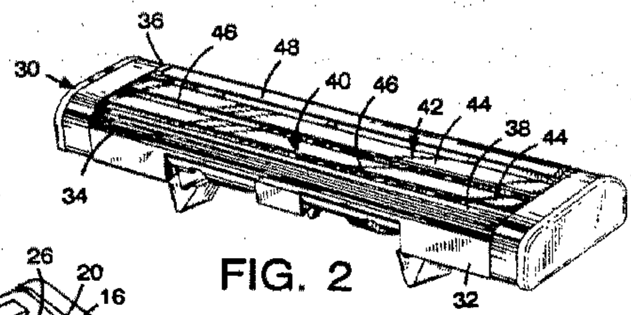


FIG. 2

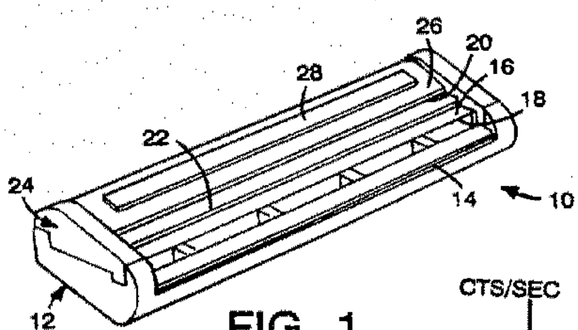


FIG. 1

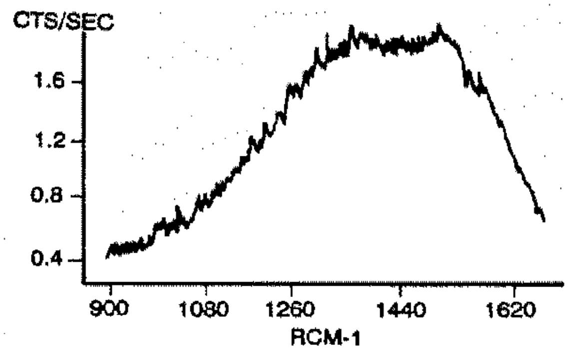


FIG. 5

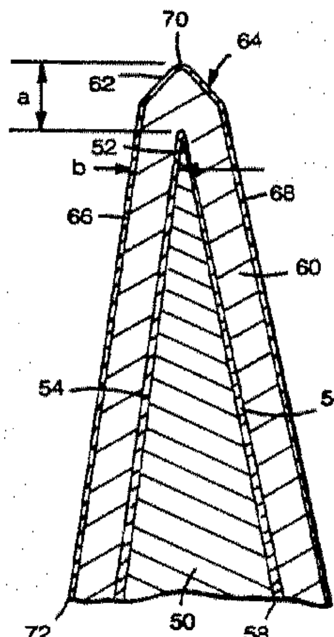


FIG. 3

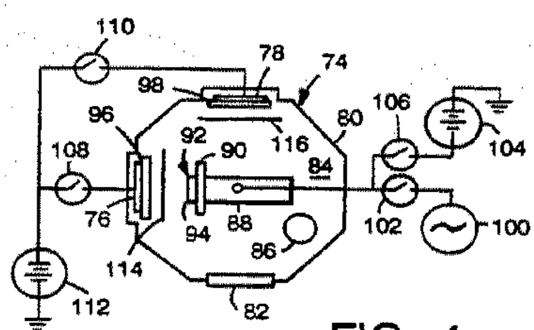


FIG. 4

## RAZOR BLADE TECHNOLOGY

This is a continuation of application Ser. No. 07/835,251, filed Feb. 13, 1992, now abandoned.

## RAZOR BLADE TECHNOLOGY

This invention relates to improved razors and razor blades and to processes for producing razor blades or similar cutting tools with sharp and durable cutting edges.

A razor blade typically is formed of suitable substrate material such as metal or ceramic and an edge is formed with wedge-shape configuration with an ultimate edge or tip that has a radius of less than about 1,000 angstroms, the wedge shaped surfaces having an included angle of less than 30°. As shaving action is severe and blade edge damage frequently results and to enhance shavability, the use of one or more layers of supplemental coating material has been proposed for shave facilitation, and/or to increase the hardness and/or corrosion resistance of the shaving edge. A number of such coating materials have been proposed, such as polymeric materials and metals, as well as other materials including diamond and diamond-like carbon (DLC) material. Each such layer or layers of supplemental material must have adhesion compatibility so that each layer remains firmly adhered to the substrate throughout the useful life of the razor blade, and desirably provide characteristics such as improved shavability, improved hardness and/or corrosion resistance while not adversely affecting the geometry and cutting effectiveness of the shaving edge. It has been proposed to provide the cutting edges of razor blades with improved mechanical properties by applying to the sharpened edge of the substrate a coating of diamond or diamond-like carbon (DLC) material. Such materials may be characterized as having substantial sp3 carbon bonding; a mass density greater than 1.5 grams/cm$^3$; and a Raman peak at about 1331 cm$^{-1}$ (diamond) or about 1552 cm$^{-1}$ (DLC). However, it has been found that under certain accelerated corrosion testing conditions such as immersion in hot distilled water at 80° C. for 16 hours, a diamond-like carbon coating can delaminate from a molybdenum interlayer and the steel blade substrate by what appears to be an electrochemical reaction.

In accordance with one aspect of the invention, there is provided a razor blade comprising a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, nickel, niobium, and niobium-molybdenum alloy and alloys of such materials on the tip and flanks of the wedge-shaped edge, the thickness of the interlayer preferably being in the range of about 50–500 angstroms, and a layer of diamond or diamond-like carbon material on the interlayer that preferably has a thickness of at least about 1200 angstroms, defines a tip radius of less than about 400 angstroms and an aspect ratio in the range of 1:1–3:1. The blade exhibits excellent shaving properties and long shaving life.

In particular embodiments, the razor blade substrate is steel; the diamond or DLC coating is at least twice as hard as the metal substrate; the wedge-shaped edge is formed by a sequence of mechanical abrading steps; and the layers of interlayer material (a preferred material being niobium) and diamond or diamond-like carbon material are formed by sputtering material from targets of the interlayer material and graphite.

In accordance with another aspect of the invention, there is provided a process for forming a razor blade that includes the steps of providing a substrate, forming on an edge of the substrate a wedge-shaped sharpened edge that has an included angle of less than 30° and a tip radius (i.e. the estimated radius of the larger circle that may be positioned within the ultimate tip of the edge when such ultimate tip is viewed under a scanning electron microscope at magnifications of at least 25,000) preferably of less than 1,200 angstroms; depositing a layer of interlayer material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, nickel, niobium, and niobium-molybdenum alloy and alloys of such materials on the sharpened edge; and depositing a layer of diamond or diamond-like material on the interlayer to provide a radius at the ultimate tip of the diamond or diamond-like carbon material of less than about 1,000 angstroms.

The interlayer and the diamond or DLC layer may be deposited by various techniques such as plasma decomposition of hydrocarbon gases, sputter deposition using ions from either a plasma or an ion gun to bombard a target, directly using a beam of carbon ions, and ion beam assisted deposition (IBAD) process using either E-Beam or sputtering sources.

In a particular process, the substrate is mechanically abraded in a sequence of honing steps to form the sharpened edge; layers of niobium and diamond or diamond-like carbon material are successively deposited by sputtering; the niobium interlayer having a thickness of less than about five hundred angstroms, and the diamond or DLC coating on the niobium coated cutting edge having a thickness of at least about twelve hundred angstroms; the layer of diamond having a Raman peak at about 1331 cm$^{-1}$ and the layer of diamond-like carbon (DLC) material having a Raman peak at about 1550 cm$^{-1}$; substantial sp3 carbon bonding; and a mass density greater than 1.5 grams/cm$^3$; and an adherent polymer coating is applied on the diamond or DLC coated cutting edge.

In accordance with another aspect of the invention, there is provided a shaving unit that comprises blade support structure that has external surfaces for engaging user skin ahead and rearwardly of the blade edge or edges and at least one blade member secured to the support structure. The razor blade structure secured to the support structure includes a substrate with a wedge-shaped cutting edge defined by facets that have an included angle of less than seventeen degrees at a distance of forty micrometers from the sharpened tip, an interlayer selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, nickel, niobium, and niobium-molybdenum alloy and alloys of such materials and a layer of strengthening material on the interlayer that has a thickness of at least twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip, and an ultimate tip defined by facets that have lengths of at least about 0.1 micrometer and define an included angle of at least sixty degrees, a radius at the ultimate tip of the strengthening material of less than 400 angstroms and an aspect ratio in the range of 1:1–3:1.

In a particular shaving unit, the razor blade structure includes two steel substrates, the wedge-shaped edges are disposed parallel to one another between the skin-engaging surfaces; a niobium interlayer is between the steel substrate and the edge strengthening layer and the edge strengthening layer is of diamond or DLC mate-

rial; each niobium layer has a thickness of less than about five hundred angstroms; each diamond or DLC coating has a thickness of about two thousand angstroms (typically a range of 1800–2200 angstroms depending on processing parameters) and is characterized by substantial sp3 carbon bonding; a mass density greater than 1.5 grams/cm$^3$; and a Raman peak at about 1331 cm$^{-1}$ (diamond) or about 1550 cm$^{-1}$ (DLC); and an adherent polymer coating is on each layer of diamond or diamond-like carbon material.

The shaving unit may be of the disposable cartridge type adapted for coupling to and uncoupling from a razor handle or may be integral with a handle so that the complete razor is discarded as a unit when the blade or blades become dull. The front and rear skin engaging surfaces cooperate with the blade edge (or edges) to define the shaving geometry. Particularly preferred shaving units are of the types shown in U.S. Pat. No. 3,876,563 and in U.S. Pat. No. 4,586,255.

Other features and advantages of the invention will be seen as the following description of particular embodiments progresses, in conjunction with the drawings, in which:

FIG. 1 is a perspective view of a shaving unit in accordance with the invention;

FIG. 2 is a perspective view of another shaving unit in accordance with the invention;

FIG. 3 is a diagrammatic view illustrating one example of razor blade edge geometry in accordance with the invention;

FIG. 4 is a diagrammatic view of apparatus for the practice of the invention; and

FIG. 5 is a Raman spectrum of DLC material deposited with the apparatus of FIG. 4.

## Description of Particular Embodiments

With reference to FIG. 1, shaving unit 10 includes structure for attachment to a razor handle, and a platform member 12 molded of high-impact polystyrene that includes structure defining forward, transversely-extending skin engaging surface 14. Mounted on platform member 12 are leading blade 16 having sharpened edge 18 and following blade 20 having sharpened edge 22. Cap member 24 of molded high-impact polystyrene has structure defining skin-engaging surface 26 that is disposed rearwardly of blade edge 22, and affixed to cap member 24 is shaving aid composite 28.

The shaving unit 30 shown in FIG. 2 is of the type shown in Jacobson U.S. Pat. No. 4,586,255 and includes molded body 32 with front portion 34 and rear portion 36. Resiliently secured in body 32 are guard member 38, leading blade unit 40 and trailing blade unit 42. Each blade unit 40, 42 includes a blade member 44 that has a sharpened edge 46. A shaving aid composite 48 is frictionally secured in a recess in rear portion 36.

A diagrammatic view of the edge region of the blades 16, 20 and 44 is shown in FIG. 3. The blade includes stainless steel body portion 50 with a wedge-shaped sharpened edge formed in a sequence of edge forming honing operations that forms a tip portion 52 that has a radius typically less than 500 angstroms with facets 54 and 56 that diverge at an angle of about 13°. Deposited on tip 52 and facets 54, 56 is interlayer 58 of niobium that has a thickness of about 300 angstroms. Deposited on niobium interlayer 58 is outer layer 60 of diamond-like carbon (DLC) that has a thickness of about 2,000 angstroms, with facets 62, 64 that have lengths of about one-quarter micrometer each and define an included angle of about 80°, facets 62, 64 merging with main facet surfaces 66, 68 that are disposed at an included angle of about 13° and an aspect ratio (the ratio of the distance (a) from DLC tip 70 to stainless steel tip 52 and the width (b) of the DLC coating 60 at tip 52) of about 1.7. Deposited on layer 60 is an adherent telomer layer 72 that has a substantial as deposited thickness but is reduced to monolayer thickness during initial shaving.

Apparatus for processing blades of the type shown in FIG. 3 is diagrammatically illustrated in FIG. 4. That apparatus includes a DC planar magnetron sputtering system manufactured by Vac Tec Systems of Boulder, Colorado that has stainless steel chamber 74 with wall structure 80, door 82 and base structure 84 in which is formed port 86 coupled to a suitable vacuum system (not shown). Mounted in chamber 74 is carousel support 88 with upstanding support member 90 on which is disposed a stack of razor blades 92 with their sharpened edges 94 in alignment and facing outwardly from support 90. Also disposed in chamber 74 are support structure 76 for target member 96 of niobium (99.99% pure) and support structure 78 for target member 98 of graphite (99.999% pure). Targets 96 and 98 are vertically disposed plates, each about twelve centimeters wide and about thirty-seven centimeters long. Support structures 76, 78 and 88 are electrically isolated from chamber 74 and electrical connections are provided to connect blade stack 92 to RF power supply 100 through switch 102 and to DC power supply 104 through switch 106; and targets 96 and 98 are connected through switches 108, 110, respectively, to DC magnetron power supply 112. Shutter structures 114 and 116 are disposed adjacent targets 96, 98, respectively, for movement between an open position and a position obscuring its adjacent target.

Carousel 88 supports the blade stack 92 with the blade edges 94 spaced about seven centimeters from the opposed target plate 96, 98 and is rotatable about a vertical axis between a first position in which blade stack 92 is in opposed alignment with niobium target 96 (FIG. 4) and a second position in which blade stack 92 is in opposed alignment with graphite target 98.

In a particular processing sequence, a stack of blades 92 (five centimeters high) is secured on support 90; chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; switch 102 is then closed and the blades 92 are RF cleaned in an argon environment for five minutes at a pressure of ten millitorr, an argon flow of 200 sccm and a power of 1.5 kilowatts; the argon flow is then reduced to 150 sccm at a pressure of 2.0 millitorr in chamber 74; switch 106 is closed to apply a DC bias of −25 volts on blades 92; switch 108 is closed to commence sputtering at one kilowatt power and shutter 114 in front of niobium target 96 is opened for thirty seconds to deposit a niobium layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 is then closed, switches 106 and 108 are opened, and carousel 88 is rotated 90° to juxtapose the blade edges of blade stack 92 with graphite target 98. Pressure in chamber 74 is maintained at two millitorr with an argon flow of 150 sccm; switch 110 is closed to sputter graphite target 98 at 750 watts; switch 102 is closed to apply a 13.56 MHz RF bias of eight hundred watts (−420 volts DC self bias voltage) on blades 92, and concurrently shutter 116 is opened for twenty minutes to deposit a DLC layer 60 of about two thousand angstroms thickness on niobium layer 58. The DLC coating 60 had a radius at tip 70 of about 350

PACE-037845

Angstroms that is defined by facets 62, 64 that have an included angle of about 80°, and an aspect ratio of about 1.9:1.

A coating 72 of polytetrafluoroethylene telomer is then applied to the DLC-coated edges of the blades. The process involves heating the blades in a neutral atmosphere of argon and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. Coatings 58 and 60 were firmly adherent to the blade body 50, provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.45 kilogram), and withstood repeated applications of wool felt cutter forces indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50, even after immersion in 80° C. distilled water for sixteen hours. Resulting blade elements 44 were assembled in cartridge units 30 of the type shown in FIG. 2 and shaved with excellent shaving results.

While a particular embodiment of the invention has been shown and described, various modifications will be apparent to those skilled in the art, and therefore, it is not intended that the invention be limited to the disclosed embodiment, or to details thereof, and departures may be made therefrom within the spirit and scope of the invention.

What is claimed is:

1. A process for forming a razor blade comprising the steps of

providing a substrate,

forming a wedge-shaped sharpened edge on said substrate that has an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms;

depositing an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said sharpened edge; and depositing a layer of diamond or diamond-like carbon (DLC) material on said interlayer.

2. The process of claim 1 wherein said substrate is mechanically abraded in a sequence of honing steps to form said sharpened edge.

3. The process of claim 1 and further including the step of applying an adherent polymer coating on said diamond or DLC coated cutting edge.

4. The process of claim 1 wherein said interlayer on said cutting edge has a thickness of less than about five hundred angstroms, and said diamond or DLC coating on said interlayer coated cutting edge has a thickness of, at least twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip.

5. The process of claim 1 wherein said substrate is of metal and said diamond or DLC coating is at least twice as hard as said metal substrate.

6. The process of claim 1 wherein said layer of diamond or DLC carbon material is deposited by a technique selected from the group consisting of plasma decomposition of hydrocarbon gases, sputter deposition using ions from either a plasma or an ion gun to bombard a graphite target, directly using a beam of carbon ions, and an ion beam assisted deposition (IBAD) process using either E-Beam or sputtering sources.

7. The process of claim 1 wherein said layer of diamond or diamond-like carbon material is deposited in an argon atmosphere in an evacuated chamber in which a graphite target and a shutter are located; said graphite target is energized; and said shutter is opened to deposit said layer of diamond or diamond-like carbon material on said sharpened edge while an RF bias is applied to said substrate.

8. The process of claim 7 and further including a niobium target in said chamber, and an interlayer of niobium is deposited on said blade edge by sputtering.

9. A process for forming a razor blade comprising the steps of providing a substrate, forming on said substrate a wedge-shaped edge that has an included angle of less than 30° and a tip radius less than 1,200 angstroms; depositing an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and depositing a layer of diamond or diamond-like carbon (DLC) material on said interlayer to provide a radius at the ultimate tip of said diamond or diamond-like carbon material of less than 1,200 angstroms.

10. The process of claim 9 wherein said interlayer and said diamond or diamond-like carbon material are deposited by sputtering.

11. The process of claim 9 wherein said interlayer on said wedge-shaped edge has a thickness of less than about five hundred angstroms, and said diamond or DLC coating on said interlayer cutting edge has a thickness of at least about twelve hundred angstroms.

12. The process of claim 11 and further including the step of applying an adherent polymer coating on said diamond or DLC coated cutting edge.

13. The process of claim 12 wherein said diamond or DLC coating on said cutting edge has a thickness of about two thousand angstroms.

14. A razor blade comprising a substrate with a wedge-shaped edge defined by facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and a layer of diamond or diamond-like carbon material on said interlayer.

15. The razor blade of claim 14 wherein said layer of diamond or diamond-like carbon (DLC) material has a Raman peak at about 1331 $cm^{-1}$ (diamond) or about 1552 $cm^{-1}$ (DLC).

16. The razor blade of claim 15 wherein said layer of diamond or diamond-like carbon (DLC) has an aspect ratio of less than about 3:1; substantial sp3 carbon bonding; and a mass density greater than 1.5 grams/$cm^3$.

17. The razor blade of claim 16 and further including an adherent polymer coating on said layer of diamond or diamond-like carbon material.

18. The razor blade of claim 17 wherein said interlayer is of niobium and has a thickness of less than about five hundred angstroms, and said diamond or DLC coating on said interlayer has a thickness of about two thousand angstroms.

19. A razor blade comprising a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on the tip and flanks of said wedge-shaped edge, the thickness of said interlayer being in the range of about 50–500 angstroms, and a layer of diamond or diamond-like carbon material

on said interlayer, said layer of diamond or diamond-like carbon material having a thickness of at least about twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip and defining a tip radius of less than about 1000 angstroms.

20. The razor blade of claim 19 wherein said substrate is steel; said wedge-shaped edge is formed by a sequence of mechanical abrading steps; said interlayer is of niobium; and said interlayer and diamond or diamond-like carbon material are formed by sputtering.

21. The razor blade of claim 20 wherein said layer of diamond or diamond-like carbon (DLC) material has substantial sp3 carbon bonding; a mass density greater than 1.5 grams/$cm^3$; and a Raman peak at about 1331 $cm^{-1}$ diamond or about 1552 $cm^{-1}$ (DLC); and further including an adherent polymer coating on said layer of diamond or diamond-like carbon material.

22. A shaving unit comprising support structure that defines spaced skin-engaging surfaces, and razor blade structure secured to said support structure, said razor blade structure including a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and a layer of diamond or diamond-like carbon material on said interlayer, said diamond or diamond-like carbon coated wedge-shaped edge being disposed between said skin-engaging surfaces.

23. The shaving unit of claim 22 wherein said razor blade structure includes two substrates, and said coated wedge-shaped edges are disposed parallel to one another between said skin-engaging surfaces.

24. The shaving unit of claim 23 wherein each said layer of diamond or diamond-like carbon material has substantial sp3 carbon bonding; a mass density greater than 1.5 grams/$cm^3$; and a Raman peak at about 1331 $cm^{-1}$ (diamond) or 1552 $cm^{-1}$ (DLC); each said interlayer has a thickness of less than five hundred angstroms; and each said diamond or DLC coating on said interlayer has a thickness of about two thousand angstroms; and further including an adherent polymer coating on each said layer of diamond or diamond-like carbon material.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 5,295,305

DATED : March 22, 1994

INVENTOR(S) : Steve S. Hahn, John Madeira, and James A. Ruth, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

TITLE PAGE:

Under section [75] Inventors, after "Assonet" delete ", both of Mass." and insert --; James A. Ruth, Jr., Randolph, all of Mass.--.

Signed and Sealed this

Third Day of October, 1995

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

US005295305B1

# REEXAMINATION CERTIFICATE (2972th)

**United States Patent** [19] | [11] **B1 5,295,305**

**Hahn et al.** | [45] Certificate Issued **Aug. 13, 1996**

[54] **RAZOR BLADE TECHNOLOGY**

[75] Inventors: **Steve S. Hahn**, Wellesley Hills; **John Madeira**, Assonet; **James A. Ruth, Jr.**, Randolph, all of Mass.

[73] Assignee: **The Gillette Company**, Boston, Mass.

**Reexamination Request:**
No. 90/003,825, May 9, 1995

**Reexamination Certificate for:**

| | |
|---|---|
| Patent No.: | **5,295,305** |
| Issued: | **Mar. 22, 1994** |
| Appl. No.: | **8,396** |
| Filed: | **Jan. 25, 1993** |

Certificate of Correction issued Oct. 3, 1995.

**Related U.S. Application Data**

[63] Continuation of Ser. No. 835,251, Feb. 13, 1992, abandoned.

[51] **Int. Cl.**$^6$ .............................. **B26B 21/54**

[52] **U.S. Cl.** .............................. **30/50**; 30/346.53; 30/346.55

[58] **Field of Search** .............................. 30/346.53, 346.54, 30/346.55, 350, 50; 427/27; 204/192.3, 192.15, 192.16; 76/104.1, 116, DIG. 8

[56] **References Cited**

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5,232,568 8/1993 Parent et al. .

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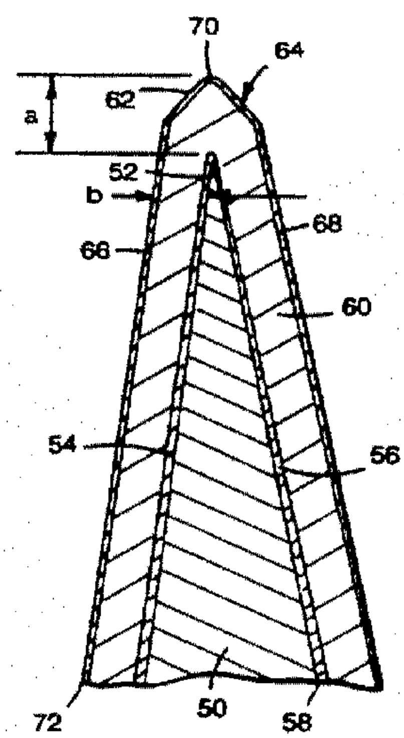
*Primary Examiner*—Huli-Sui Payer

[57] **ABSTRACT**

A razor blade includes a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of silicon, silicon carbide, vanadium, tantalum, nickel, niobium, and niobium-molybdenum alloy and alloys of such materials on the tip and flanks of the wedge-shaped edge, the thickness of the interlayer preferably being in the range of about 50–500 angstroms, and a layer of diamond or diamond-like carbon material on the interlayer that preferably has a thickness of about two thousands angstroms and that defines a tip radius of less than about 1000 angstroms.



# REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

**Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.**

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

Claims **1**, **9**, **14**, **19** and **22** are determined to be patentable as amended.

Claims **2–8**, **10–13**, **15–18**, **20**, **21**, **23** and **24**, dependent on an amended claim, are determined to be patentable.

New claims **25–44** are added and determined to be patentable.

**1**. A process for forming a razor blade comprising the steps of providing a substrate, forming a wedge-shaped sharpened edge on said substrate that has an included angle of less than thirty degrees and a trip radius of less than twelve hundred angstroms; depositing an interlayer of material selected from the group consisting of **[**silicon,**]** silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said sharpened edge; and depositing a layer of diamond or diamond-like carbon (DLC) material on said interlayer.

**9**. A process for forming a razor blade comprising the steps of providing a substrate, forming on said substrate a wedge-shaped sharpened edge that has an included angle of less than 30° and a tip radius of less than 1,200 angstroms; depositing an interlayer of material selected from the group consisting of **[**silicon,**]** silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and depositing a layer of diamond or diamond-like carbon (DLC) material on said interlayer to provide a radius at the ultimate tip of said diamond or diamond-like carbon material of less than 1,200 angstroms.

**14**. A razor blade comprising a substrate with a wedge-shaped edge defined by facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, an interlayer of material selected from the group consisting of **[**silicon,**]** silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and a layer of diamond or diamond-like carbon material on said interlayer.

**19**. A razor blade comprising a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of **[**silicon**]** silicon carbide vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on the tip and flanks of said wedge-shaped edge, the thickness of said interlayer being in the range of about 50–500 angstroms, and a layer of diamond or diamond-like carbon material on said interlayer, said layer of diamond or diamond-like carbon material having a thickness of at least about twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip and defining a tip radius of less than about 1000 angstroms.

**22**. A shaving unit comprising support structure that defines spaced skin-engaging surfaces, and razor blade structure secured to said support structure, said razor blade structure including a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of **[**silicon,**]** silicon carbide, vanadium, tantalum, niobium, and niobium-molybdenum alloy and alloys of such materials on said wedge-shaped edge; and a layer of diamond or diamond-like carbon material on said interlayer, said diamond or diamond-like carbon coated wedge-shaped edge being disposed between said skin-engaging surfaces.

*25. The process of claim 1 wherein said interlayer material is silicon carbide.*

*26. The process of claim 1 wherein said interlayer material is vanadium.*

*27. The process of claim 1 wherein said interlayer material is tantalum.*

*28. The process of claim 1 wherein said interlayer material is niobium.*

*29. The process of claim 1 wherein said interlayer material is niobium-molybdenum alloy.*

*30. The razor blade of claim 14 wherein said interlayer material is silicon carbide.*

*31. The razor blade of claim 14 wherein said interlayer material is vanadium.*

*32. The razor blade of claim 14 wherein said interlayer material is tantalum.*

*33. The razor blade of claim 14 wherein said interlayer material is niobium.*

*34. The razor blade of claim 14 wherein said interlayer material is niobium-molybdenum alloy.*

*35. The razor blade of claim 19 wherein said interlayer material is silicon carbide.*

*36. The razor blade of claim 19 wherein said interlayer material is vanadium.*

*37. The razor blade of claim 19 wherein said interlayer material is tantalum.*

*38. The razor blade of claim 19 wherein said interlayer material is niobium.*

*39. The razor blade of claim 19 wherein said interlayer material is niobium-molybdenum alloy.*

*40. The shaving unit of claim 22 wherein said interlayer material is silicon carbide.*

*41. The shaving unit of claim 22 wherein said interlayer material is vanadium.*

*42. The shaving unit of claim 22 wherein said interlayer material is tantalum.*

*43. The shaving unit of claim 22 wherein said interlayer material is niobium.*

*44. The shaving unit of claim 22 wherein said interlayer material is niobium-molybdenum alloy.*

* * * * *

# Exhibit 2

US005940975A

# United States Patent [19]

**Decker et al.**

[11] **Patent Number: 5,940,975**

[45] **Date of Patent: Aug. 24, 1999**

[54] **AMORPHOUS DIAMOND COATING OF BLADES**

[76] Inventors: **Thomas G. Decker**, 257 Pheasant Ave., Arlington, Mass. 02154; **Gregory P. Lundy**, 11743 Fenton St., Westminster, Colo. 80021; **David L. Pappas**, 603A Kings Way, Waltham, Mass. 02154; **Richard P. Welty**, 4279-C Monroe Dr., Boulder, Colo. 80303; **C. Robert Parent**, 69 Hawthorne St., Westwood, Mass. 02090

[21] Appl. No.: **08/877,137**

[22] Filed: **Jun. 17, 1997**

**Related U.S. Application Data**

[62] Division of application No. 08/825,405, Mar. 27, 1997, Pat. No. 3,799,549, which is a continuation of application No. 08/232,928, Apr. 25, 1994, abandoned.

[51] **Int. Cl.**$^6$ ..................... **B26B 21/60**

[52] **U.S. Cl.** .................. **30/346.54**; 76/104.1; 76/DIG. 8; 76/DIG. 12

[58] **Field of Search** ..................... 76/104.1, DIG. 8, 76/DIG. 12; 30/346.54, 346.53, 346.5

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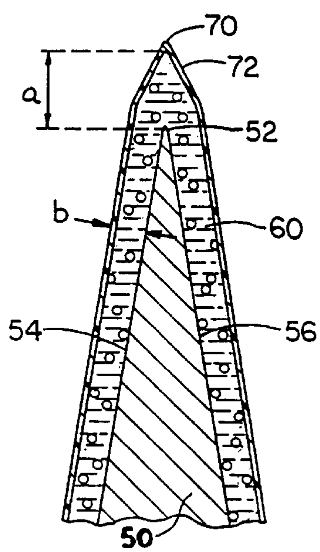
*Primary Examiner*—Douglas D. Watts
*Attorney, Agent, or Firm*—Davis, Graham & Stubbs, LLP

[57] **ABSTRACT**

Improved razors and razor blades and processes for producing razor blades or similar cutting tools with sharp and durable cutting edges, by hard-carbon coating of blades with amorphous diamond, preferably using a filtered cathodic arc plasma source. A coating of amorphous diamond having at least 40 percent sp3 carbon bonding, a hardness of at least 45 gigapascals and a modulus of at least 400 gigapascals is applied to the sharpened edge of a substrate. The substrate may be mechanically honed, and there is no interlayer between the substrate and the amorphous diamond coating. The coating imparts stiffness and rigidity to a thin blade while maintaining a high aspect ratio.

**13 Claims, 2 Drawing Sheets**

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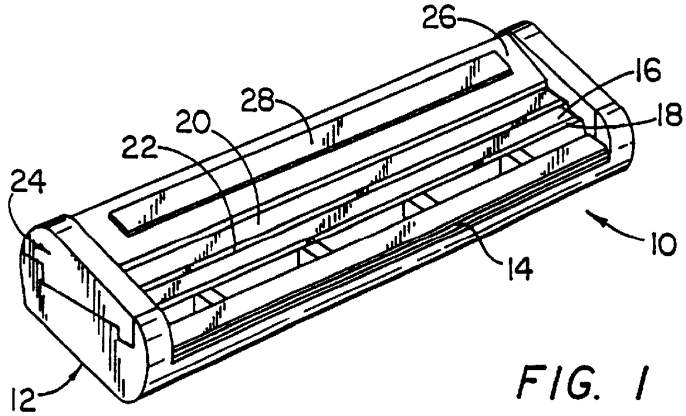


FIG. 1

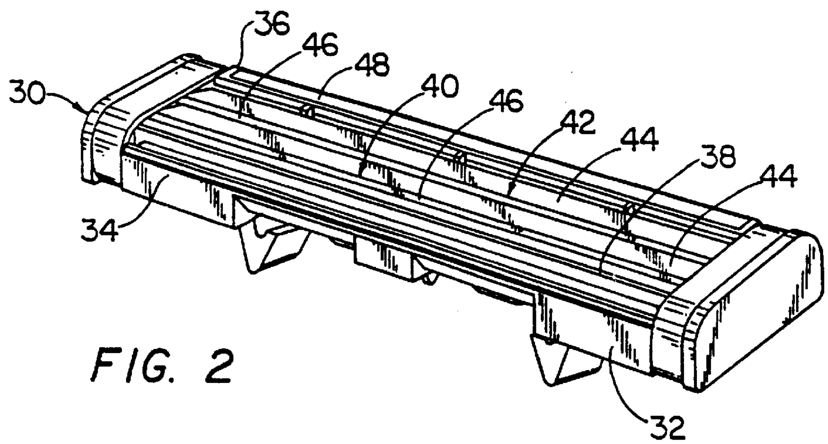


FIG. 2

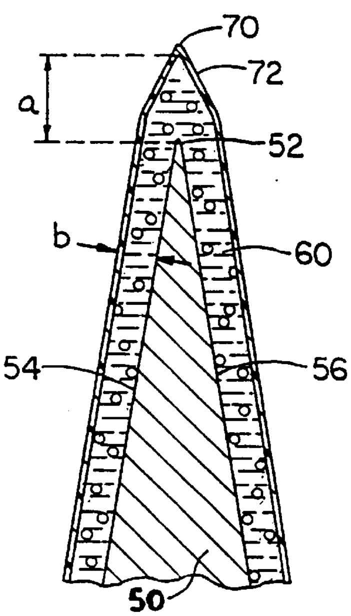


FIG. 3

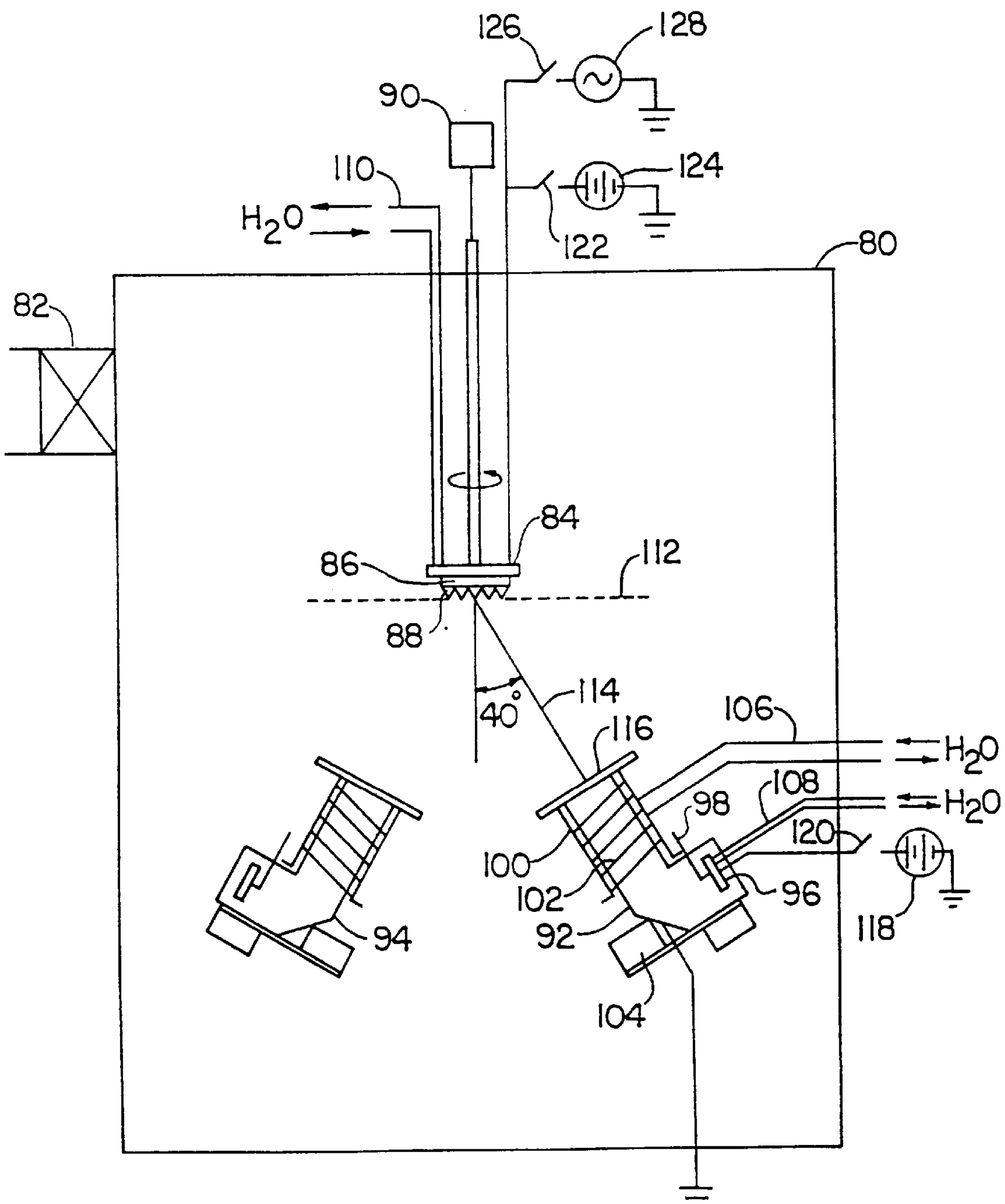
126
128
90
110
124
$H_2O$
122
80
82
84
86
112
88
114
40°
106
116
$H_2O$
108
98
$H_2O$
120
100
96
102
118
94
92
104

FIG. 4

# AMORPHOUS DIAMOND COATING OF BLADES

This is a divisional application Ser. No. 08/825,405 now U.S. Pat. No. 3,799,549 filed on Mar. 27, 1997, which is, in turn, a file wrapper continuation of application Ser. No. 08/232/928 filed on Apr. 25, 1994 now abandoned.

## FIELD OF THE INVENTION

This invention relates to improved razors and razor blades and to processes for producing razor blades or similar cutting tools with sharp and durable cutting edges, and in particular to amorphous diamond coating of blades using a filtered cathodic arc plasma source. The invention has particular utility for forming a very hard and rigid coating of high aspect ratio on very thin cutting edges of razor blades.

## BACKGROUND OF THE INVENTION

A razor blade typically is formed of suitable substrate material such as metal or ceramic, and an edge is formed with wedge-shape configuration with an ultimate edge or tip that has a radius of less than about 1,000 angstroms, the wedge shaped surfaces having an included angle of less than 30°. As shaving action is severe and blade edge damage frequently results and to enhance shavability, the use of one or more layers of supplemental coating material has been proposed for shave facilitation, and/or to increase the hardness and/or corrosion resistance of the shaving edge.

A number of such coating materials have been proposed, such as polymeric materials and metals, as well as other materials including diamond-like carbon (DLC) material. Each such layer or layers of supplemental material must have adhesion compatibility so that each layer remains firmly adhered to the substrate throughout the useful life of the razor blade, and desirably provide characteristics such as improved shavability, improved hardness and/or corrosion resistance while not adversely affecting the geometry and cutting effectiveness of the shaving edge.

U.S. Pat. No. 5,032,243 of Bache et al. describes blade substrate materials sharpened by ion bombardment from ion sources having the axes of their beams directed at the edges of the razor blades. U.S. Pat. No. 5,232,568 of Parent et al. and U.S. Pat. No. 5,295,305 of Hahn et al. show blades which have an interlayer interposed between the substrate and the diamond-like coating, wherein the inter-layer is deposited on the substrate and then the diamond-like coating is deposited on the interlayer.

The prior solutions are not entirely successful, and it would be desirable simply to use mechanical honing processes to form the sharpened substrate (rather than the ion beam formation shown in Bache et al.) followed by a direct deposition of amorphous diamond coating on the substrate (without the intervening step of depositing an interlayer). It would be desirable, therefore, to be able to start with a thin blade substrate produced by mechanical honing and to impart both rigidity and hardness to the substrate by depositing an amorphous diamond coating directly on the substrate.

## SUMMARY OF THE INVENTION

According to this invention, the cutting edges of razor blades are provided with improved mechanical properties by applying to the sharpened edge of the substrate a coating of an amorphous diamond material. Such materials may be characterized as having at least 40 percent sp3 carbon



bonding, a hardness of at least 45 gigapascals and a modulus of at least 400 gigapascals. In addition, such materials are not corroded by hot aqueous solutions and compounds commonly used in shaving. Materials having these characteristics will be denoted as amorphous diamond in the further course of this disclosure. In contrast to the amorphous diamond material of this invention, traditional diamond-like carbon coatings (DLC) produced by such traditional methods as sputtering do not exhibit such high hardnesses. Unlike the amorphous diamond of this disclosure, DLC coatings typically have hardnesses not exceeding 30 gigapascals.

The extreme hardness and rigidity of the applied amorphous diamond coating can provide strength to a very thin razor blade edge. U.S. Pat. No. 4,720,918 of Curry et al. describes edges of this type, and they are included here as examples and need not be considered limiting. A very thin blade edge can provide increased shaving comfort, but is practical only if the edge is strong enough to withstand shaving. A thin edge, including but not limited to those described in U.S. Pat. No. 4,720,918, strengthened by 400 to 2000 angstroms of amorphous diamond will comprise a finished edge which is significantly thinner than edges presently used for shaving, coupled with sufficient strength to withstand shaving, this due to the extraordinary strength of the amorphous diamond coating.

Further contributing to a thin edge is the large aspect ratio attainable by the particular cathodic arc deposition process used in this invention for manufacture of amorphous diamond coatings. The "aspect ratio" is explained in greater detail with reference to FIG. **3** in the discussion which follows, but may be understood for purposes of this summary as being the ratio of (a) to (b) where (a) is a first distance from the tip of the coating to the tip of the substrate, and (b) is a second distance from a surface of the coating to the tip of the substrate.

The aspect ratio provides a useful measure of the effect of a coating on the underlying blade edge geometry of the substrate—the larger or higher the aspect ratio of the coating, the "sharper" is the coated blade compared to a blade coated at a lower aspect ratio. As a further consequence of the extraordinary strength of the amorphous diamond coatings of this invention, application of such a coating to a razor blade of normal cross-section will be expected to provide longer shaving life.

In accordance with one aspect of the invention, there is provided a wedge-shaped edge and a layer of amorphous diamond on the tip and flanks of the wedge-shaped edge, preferably with a thickness of at least 400 angstroms, which defines a tip radius of less than about 500 angstroms and an aspect ratio of 2:1 to 4:1. The blade exhibits excellent shaving properties and long life.

In preferred embodiments, the razor blade substrate is steel, the amorphous diamond coating is at least four times as hard as the steel substrate; the wedge-shaped edge is formed by a sequence of mechanical abrading steps; and the layer of amorphous diamond is formed of carbon ions provided from a graphite target used as a filtered cathodic arc source.

In accordance with another aspect of the invention, there is provided a process for forming a razor blade that includes the steps of providing a substrate; forming on an edge of the substrate a wedge-shaped sharpened edge that has an included angle of less than 30° and a tip radius (i.e. the estimated radius of the largest circle that may be positioned within the ultimate tip of the edge when such ultimate tip is

viewed under a scanning electron microscope at magnifications of at least 25,000) preferably of less than 1,200 angstroms; and depositing, by filtered cathodic arc evaporation, a layer of amorphous diamond on the sharpened edge to provide a radius at the ultimate tip of the amorphous diamond layer of less than about 1000 angstroms. The amorphous diamond layer may be deposited by several techniques, all having in common the energetic deposition of carbon as a highly ionized species. While methods of cathodic arc, anodic arc, plasma decomposition of hydrocarbon gases, sputtering with post-ionization by inductively coupled rf, laser ablation, laser absorptive wave deposition (LAWD) and direct ion beam deposition might be used for this purpose, the preferred embodiment of this invention uses a filtered cathodic arc.

In a particular process, the substrate is mechanically abraded in a sequence of honing steps to form the sharpened edge; a layer of amorphous diamond is deposited by filtered cathodic arc, the amorphous diamond coating on the cutting edge having a thickness of at least 400 angstroms, the layer of amorphous diamond having at least 40 percent sp3 carbon bonding, a hardness of at least 45 gigapascals; and an adherent polymer coating may be applied on the amorphous diamond coated cutting edge.

In accordance with another aspect of the invention, there is provided a shaving unit that comprises blade support structure that has external surfaces for engaging user skin ahead and rearwardly of the blade edge or edges and at least one blade member secured to the support structure. The razor blade structure secured to the support structure includes a substrate with a wedge-shaped cutting edge defined by facets that have an included angle of less than seventeen degrees at a distance of forty micrometers from the sharpened tip, and a layer of a strengthening material which has a thickness of at least 400 angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip, a radius at the ultimate tip of the strengthening material of less than 500 angstroms and an aspect ratio in the range of 2:1 to 4:1.

In a particular shaving unit, the razor blade structure includes two steel substrates, the wedge-shaped edges are disposed parallel to one another between the skin-engaging surfaces, the edge strengthening layer is of amorphous diamond with a thickness of about 1000 angstroms (typically a range of 400–2000 angstroms depending on substrate and processing parameters) and is characterized by at least 40 percent sp3 carbon bonding and a hardness of at least 45 gigapascals; and an adherent polymer coating is on each layer of amorphous diamond material.

The shaving unit may be of the disposable cartridge type adapted for coupling to and uncoupling from a razor handle or may be integral with a handle so that the complete razor is discarded as a unit when the blade or blades become dull. The front and rear skin engaging surfaces cooperate with the blade edge (or edges) to define the shaving geometry. Particularly preferred shaving units are of the types shown in U.S. Pat. No. 3,876,563 and in U.S. Pat. No. 4,586,255.

Other features and advantages of the invention, including process conditions for applying the desired amorphous diamond coating will be seen as the following description of particular embodiments progresses, in conjunction with the drawings.

## DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a shaving unit in accordance with the invention;

FIG. **2** is a perspective view of another shaving unit in accordance with the invention;

FIG. **3** is a diagrammatic view illustrating one example of razor blade edge geometry in accordance with the invention;

FIG. **4** is a diagrammatic view of apparatus for the practice of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

In the description which follows, the characteristics and properties of various preferred embodiments of the blade, substrate and amorphous diamond coating will be disclosed, followed by a disclosure of process conditions for depositing the desired coating.

With reference to FIG. **1**, shaving unit **10** includes structure for attachment to a razor handle, and a platform member **12** molded of high-impact polystyrene that includes structure defining forward, transversely-extending skin engaging surface **14**. Mounted on platform member **12** are leading blade **16** having sharpened edge **18** and following blade **20** having sharpened edge **22**. Cap member **24** of molded high-impact polystyrene has structure defining skin-engaging surface **26** that is disposed rearwardly of blade edge **22**, and affixed to cap member **24** is shaving aid composite **28**.

The shaving unit **30** shown in FIG. **2** is of the type shown in U.S. Pat. No. 4,586,255 of Jacobson and includes molded body **32** with front portion **34** and rear portion **36**. Resiliently secured in body **32** are guard member **38**, leading blade unit **40** and trailing blade unit **42**. Each blade unit **40**, **42** includes a blade member **44** that has a sharpened edge **46**. A shaving aid composite **48** is frictionally secured in a recess in rear portion **36**.

A diagrammatic view of the edge region of the blades **16**, **20** and **44** is shown in FIG. **3**, from which the aspect ratio may be better understood. The blade includes stainless steel body portion **50** with a wedge-shaped sharpened edge formed in a sequence of edge forming honing operations that forms a tip portion **52** that has a radius typically less than 500 angstroms with facets **54** and **56** that diverge at an angle of about 13°. Deposited on tip **52** and facets **54**, **56** is amorphous diamond **60** that has a thickness of about 2,000 angstroms, with an aspect ratio (the ratio at distance (a) from amorphous diamond tip **70** to stainless steel tip **52**, and the width (b) of the amorphous diamond coating **60** to tip **52**) of about 3:1.

Deposited on layer **60** is an adherent telomer layer **72** that has a substantial as deposited thickness but is reduced to monolayer thickness during initial shaving.

An apparatus for processing blades of the type shown in FIG. **3** is schematically illustrated in FIG. **4**. That apparatus includes a filtered cathodic arc deposition system, such as one manufactured by Vapor Technologies of Boulder, Colo. that has stainless steel chamber **80** which is coupled to a vacuum pumping system (not shown) through valve **82**. Mounted in chamber **80** is an electrically isolated, water cooled substrate platform **84** on which is disposed a rotatable fixture **86** which holds a stack of razor blades **88**.

The sharpened edges are aligned perpendicularly to the plane of the drawing and face downward from the support **86**. Motor **90** fixed outside the chamber **80** provides 180 degrees of rotation of the blade stack at predetermined intervals for the purpose of alternately exposing each blade edge to the beam of carbon ions from a single cathodic arc source **92**, insuring uniform deposition on both blade bevels.

Also disposed in chamber **80** are two filtered cathodic arc sources **92,94**, each consisting of a graphite target **96** (cathode, 99.99% purity), an arc striking mechanism **98**, and a filter or duct **100**. The filter **100** serves to direct the flow of carbon ions (the arc plasma) from the cathode **96** to the blade stack **88**, through the use of solenoidal magnetic fields produced by electrical windings **102** along the length of the duct and an electromagnet **104** positioned under the duct. The cathodic arc source may also be of the type described in, and the magnetic fields may be controlled so as to optimize the performance of the arc relative to the sources as described in U.S. Pat. application Ser. No. 08/233,006 of Welty now U.S. Pat. No. 5,480,527, incorporated by reference herein and a copy of which is included in this portion of the patent application as Attachment A. Water cooling lines **106**, **108** and **110** are provided for the target **96**, duct **92** and blade support **86**, respectively.

The duct is so directed to provide an angle of 40 degrees between the plane **112** presented by the blade tips and the center axis **114** of the duct exit **114**. This angle is chosen to insure that a fully dense coating is deposited. The graphite target **96** is approximately 30 centimeters long by 2.5 centimeters wide and is electrically insulated from the chamber **80**, while the duct **100** is at ground potential. The graphite target **96** is connected to a DC power supply **118** through switch **120**. Electrical wiring is provided to connect blade stack **88** through switch **122** to DC power supply **124** or through switch **126** to RF power supply **128**. The details of a preferred filtered cathodic arc design and operation are discussed further in the previously mentioned co-pending U.S. Pat. application Ser. No. 08/233,006 of Welty.

Rotatable mount **86** supports the blade stack **88** with edges spaced 15 centimeters from the mouth of the filter duct. The blade stack **88** is rotated between a position where one bevel faces the duct **92**, and a similar position where the opposite bevel faces the duct **92**. This rotation of 180 degrees is carried out every 10 seconds, insuring the bevels are coated equally.

In one example of a particular processing sequence, a stack of blades **88** (2.5 centimeters long) is secured on the rotatable mount **86**, the support cooling water is turned on, and the chamber **80** is evacuated. The pressure to chamber **80** is adjusted to 50 millitorr with flowing argon. Switch **122** is closed to provide −400 volts DC to the blade stack, igniting a DC plasma discharge in which the blades are cleaned for ten minutes. After the cleaning step, (i) the pressure in the chamber is adjusted to 0.1 millitorr of argon, (ii) the field coils **102** to a single duct **92** are energized, (iii) switch **120** to graphite target **96** is closed, (iv) the power supply **124** to the blades is adjusted to −1000 volts DC, and (v) an arc is struck/initiated on graphite target **96** with mechanical striker **98**. The arc current is set to 100 A. An intense plasma of carbon ions is emitted from duct **92** and is deposited on the blades **88**, which rotate 180 degrees every 10 seconds.

After the arc has run for 2 minutes, the bias supply **124** is set to −50 volts and deposition continues for a total time of 16 minutes. The resultant amorphous diamond blade coating is approximately 1000 angstroms in thickness on each facet. The blade tip radius is approximately 350 angstroms, and the aspect ratio is approximately 2.5:1.

In another example of the processing sequence, the two cathodic arc sources are simultaneously operated, with the second source **94** positioned opposite the first source **92**, so that both blade facets are simultaneously coated at approximately the same angle of incidence. In this case, the blade stack **88** is not rotated, but is rather translated through the region where the plasmas emitted from both sources intersect. All other aspects of the processing sequence are identical to those indicated above.

A coating **72** of polyterrafluorethylene (PTFE) telomer is then applied to the amorphous diamond coated edges of the blades. The process involves heating the blades in a neutral atmosphere of argon and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. Coatings **72** and **60** were firmly adherent to the blade body **50**, provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.45 kilogram), and withstood repeated applications of wool felt cutter forces indicating that the amorphous diamond coating **60** is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body **50**, even after immersion in 80° C. distilled water for sixteen hours.

Resulting blade elements **44** were assembled in cartridge units **30** of the type shown in FIG. **2** and shaved with excellent shaving results.

## PROCESS CONDITIONS

The foregoing disclosure of the characteristics and properties of the blades, substrates and amorphous diamond coatings may be further understood and enhanced by the following specific description of suitable process conditions generally described above. First, the preferred cathodic arc sources will be summarized. Then various preferred process conditions will be described.

Cathodic Arc Source. A deposition coating of amorphous diamond may be applied using conventional filtered cathodic arc plasma source material as described in U.S. Pat. No. 5,279,723 of Falabella et al. However, in a preferred embodiment, the deposition coating is applied according to the previously referenced co-pending application which is appended as Attachment A hereto. Although the rectangular source of Attachment A is particularly suited to the practice of this invention, the invention is not so limited. Likewise, an unfiltered or other conventional source may be used, and this invention should not be understood as being limited to filtered cathodic arc sources.

Process Conditions and Adjustments. Process conditions include a multi-step bias to the substrate; an equal average deposition on both sides of the blade; and attention to the angle of presentation.

An initial high bias in the range of 200–2000 volts is applied to the substrate during deposition for up to two minutes to establish adhesion. A second stage lower bias in the range of 10–200 volts is then applied to optimize the structure of the amorphous diamond hard carbon coating and to establish the desired crystal structure. Although at least the foregoing two stages are desirable according to this invention, it may also be desirable to provide a further "step down" incremental bias voltage reduction as, for example by adding an intermediate bias stage at 500 volts.

The amorphous diamond deposition is laid down at an equal average rate (or simultaneously) on both sides of the blade. By setting at least dual sources for simultaneous deposition and/or cycling the angle of presentation of the blade set relative to the deposition source, the coating layer will be applied equally or at an equal average rate of deposit, on both sides. In light of the fact that the blades each have a cutting edge bounded by a first inclined surface and a second inclined surface, coming to a tip at the juncture of the inclined surfaces and that a set of blades:

may be disposed as a stack of blades presenting a plane surface formed by the tips, or

may be disposed in a carousel, or otherwise; the layered concept involves either (i) using at least two sources so that the deposition rate is instantaneously equal on both sides of the cutting edge, or (ii) employing a movement of the blade set (stack or carousel) relative to a single source (a cyclic alternation of the presentation of the blades with respect to the source, as by a flipping of the stack, a rotation of the carousel, or other sequential presentation) in order that a coating will be laid down on both sides of the cutting edge of each razor at an approximately equal rate over time.

That is, in order to apply a coating of 1000 angstroms in thickness, a preferred method of this invention would not lay down all 1000 angstroms on the first side and then lay down all 1000 angstroms on the second side of a blade stack—instead, it would be either (i) a simultaneous deposition on both sides or (ii) a cyclic alternation in a range of 3 to 500 angstroms on the first side then 3 to 500 angstroms on the second side, and so on until the 1000 angstrom or other desired thickness is built on both sides of the cutting edge of each blade. While the foregoing is a preferred method, the invention is not to be understood as so limited, and may be practiced with an uneven or unbalanced layering.

It should be understood that the angle of presentation is of some concern. The low pressure (high vacuum) conditions produce a highly directional plasma stream of ionized carbon. The blades are presented at an angle measured from a line normal to the plane formed by the tips of the stacked blades (or measured from the line bisecting the angle enclosed by the tip and the first and second inclined surfaces of the cutting edge of an unstacked blade) that is greater that 20° but less than 90°. The angle of presentation is intended to direct the plasma stream more directionally against one or the other sides of the cutting edges of the blades.

As is conventionally known, the deposition process of this invention may be operated with or without a process gas such as argon; cleaning of the chamber may be accomplished with RF or DC glow discharge; and biasing of the substrate may be done with DC or RF sources (and such biasing may be used to shape the tip of the blade).

It should now be seen that this invention permits the strengthening of a thin blade while maintaining sharpness (that is, imparting stiffness and rigidity to the thin blade without ruining the acuteness or sharpness of the tip). Where a more conventional razor blade might be coated to a thickness in the order of a magnitude of about 100 to 350 angstroms, the method of this invention will deposit an amorphous diamond coat perhaps as high as 3,000 angstroms in thickness (as measured on the blade surface disposed away from the tip) and as high as 5,000 angstroms measured at the tip. As previously mentioned, all of this is achieved while maintaining a high aspect ratio.

It might be noted that the razor blades intended to be coated by this method are expected to be thinner than the usual razor blade, and sharper, and that the 2:1 and higher aspect ratios permitted by the process of this invention, coupled with the enormous strength of the amorphous diamond hard carbon coating, puts the blade in a class by itself.

What is claimed is:

**1**. A razor blade comprising a substrate with a wedge-shaped edge defined by facets that have a width of at least about 0.1 millimeter and an included angle of less than 20 degrees and a layer of amorphous diamond on said wedge-shaped edge, said layer of amorphous diamond having been deposited by a high energy source, said high energy source being one which deposits carbon particles having an energy in the range of 10–200 electron volts.

**2**. The razor blade of claim **1** wherein said layer of amorphous diamond material is characterized by at least 40 percent sp3 carbon bonding and transparency in the visible light region.

**3**. The razor blade of claim **2** wherein said layer of amorphous diamond has an aspect ratio greater than 2:1.

**4**. The razor blade of claim **3** and further including an adherent polymer coating on said layer of amorphous diamond material.

**5**. The razor blade of claim **4** wherein said amorphous diamond coating has a thickness of about 2000 angstroms.

**6**. A razor blade comprising a substrate with a wedge-shaped edge and a layer of amorphous diamond material on the tip and flanks of said wedge-shaped edge, said layer of amorphous diamond material having a thickness of at least about 400 angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip and defining a tip radius of less than about 1000 angstroms, said layer of amorphous diamond having been deposited by a high energy source, said high energy source being one which deposits carbon particles having an energy in the range of 10–200 electron volts.

**7**. The razor blade of claim **6** wherein said substrate is steel; said wedge-shaped edge is formed by a sequence of mechanized abrading steps and said amorphous diamond material is formed by a cathodic arc process.

**8**. The razor blade of claim **7** wherein said layer of amorphous diamond material has at least 40 percent sp3 carbon bonding, and further including an adherent polymer coating on said layer of amorphous diamond material.

**9**. A shaving unit comprising a support structure having spaced apart skin-engaging surfaces, and a razor blade structure secured to said support structure, said razor blade structure including a substrate with a wedge-shaped edge and a layer of amorphous diamond on said wedge-shaped edge, said amorphous diamond coated wedge-shaped edge being disposed between said skin-engaging surfaces, said layer of amorphous diamond having been deposited by a high energy source, said high energy source being one which deposits carbon particles having an energy in the range of 10–200 electron volts.

**10**. The shaving unit of claim **9** wherein said razor blade structure includes two substrates having wedge-shaped edges, and wherein said wedge-shaped edges are disposed parallel to one another between said skin-engaging surfaces.

**11**. The shaving unit of claim **10** wherein each said layer of amorphous diamond material has more than 40 percent sp3 carbon bonding; each said amorphous diamond coating has a thickness of about two thousand angstroms; and further including an adherent polymer coating on each said layer of amorphous diamond material.

**12**. A blade having a cutting edge bounded by a first inclined surface and a second inclined surface, said cutting edge having a tip at the juncture of said first and second inclined surfaces, and enclosing an angle defined by the tip and the first and second inclined surfaces,

wherein said cutting edge includes a hard carbon coating deposited upon the first and second inclined surfaces so that the coating covers the tip, and

wherein said hard carbon coating has a first thickness measured normal to one of said first and second inclined surfaces, and said coating has a second thickness measured along a line which bisects said angle; the ratio of said second thickness to said first thickness being at least 2 to 1,

said hard carbon coating having a hardness of at least 40 gigapascals, said hard carbon coating having been deposited by a high energy source, said high energy source being one which deposits carbon particles having an energy in the range of 10–200 electron volts.

13. A razor blade comprising a substrate with a wedge-shaped edge and a layer of amorphous diamond material on the tip and flanks of said wedge-shaped edge, said layer of amorphous diamond material having a thickness of at least about 250 angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip and defining a tip radius of less than about 1000 angstroms, said layer of amorphous diamond having been deposited by a high energy source, said high energy source being one which deposits carbon particles having an energy in the range of 10–200 electron volts.

* * * * *

# Exhibit 3

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I, Toyu Yazaki, hereby declare that I am a professional interpreter and translator and am knowledgeable of and well acquainted with the Japanese language and the English language.

I have translated into English the Japanese text that appears in pages 1/88 through 60/88 and page 76/88 of the original document, which respectively correspond to the same page numbers in the translated document attached hereto, as well as the Japanese text that appears in the headers of every page in the original document.

The document in the English language attached hereto is to the best of my ability, knowledge and expertise the correct English translation of the original document written in the Japanese language.

I declare under penalty of perjury under the laws of United States that the foregoing is true and correct. Executed this 23rd day of February 2017 at Seattle, Washington.

Toyu Yazaki

Patent

# Patent No. 4964383

## Identification Section

| Display No. (Additional notes) | Registered Items | | | | |
|---|---|---|---|---|---|
| No. 1 | Filing date | February 27, 2001 | | Application No. | 2001－563289 |
| | Patent grant date | February 28, 2012 | | No. of claims | 9 |
| | Priority claim | Country name | United States of America | | |
| | | Filing date | February 29, 2000 | Number of cases | 1 |
| | Title of the invention | Razor blade technology | | | |
| | | | | Date registered: April 6, 2012 | |

## Patent Fee Records

Patent fees

1st year: Amount: 4,100 yen Payment date: March 28, 2012
2nd year: Amount: 4,100 yen Payment date: March 28, 2012
3rd year: Amount: 4,100 yen Payment date: March 28, 2012
4th year: Amount: 11,600 yen Payment date: March 20, 2015
5th year: Amount: 10,900 yen Payment date: April 1, 2015

## Patentee

| Rank No. (Additional notes) | Registered Items |
|---|---|
| No. 1 | IP/Legal Patent Department 3E, The Gillette Company,<br>World Shaving Headquarters, One Gillette Park, Boston, MA, U.S.A.<br>Nationality: U.S.A. Registration date: April 6, 2012 |

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This is to certify that the above is identical to the matters recorded in the patent register.
February 13, 2017
Kazuhiro Tsukahara
Ministry of Economy, Trade and Industry Official

Patent: 2001-563289 (2/27/2001)

Application (1) (2001−563289) (13. 02. 27) Code ( ) Application type (01 ) New law
Unexamined publication ( ) ( ) Publication reference date 12. 02. 29) Domestic priority (0)
Examined publication ( ) (24. 06. 27) Priority (US 09/515, 421 00. 02. 29) No other country
Appeal (80) (2012−000717) (24. 01. 13) In charge (3C00−3505) ( Masao Kanemoto )
Registration ( 4964383) (24. 04. 06) Opposition ( 0) No. of claims ( 9) Filing fee ( 21, 000)
Publication decision (Drafting ) (By ) References (1) Novelty (0) Bacterial deposit (0) Pollution ( )
Decision (1) Drafting 24. 02. 28) (By 3505) Reconsideration (24. 01. 23) Release ( ) Public policy/ Abstract (0)
Dispatching 24. 03. 02) (By ) Examination request ( 1− ) Not requested (1) Automatic drafting ( )
Final (A01) (24. 04. 06) Preparation for publication ( ) Accelerated examination ( )
Changes to ( ) ( ) ( ) Decision ( ) ( ) Correction made after publication
Original application ( ) ( ) ( ) Type ( )
Extension of time (23. 02. 14) Final drafting date (24. 02. 28)
Publication of translation (2003−525098) (15. 08. 26) Submission of translation (02. 06. 13) International application (PCT/US01/06206 )
Re-publication ( ) International publication (WO01/64406 01. 09. 07) Foreign language
Publication IPC7 B26B 21/60 FN Assigned classification IPC B26B 21/
Examined publication IPC4 B26B 21/60 FIC
Title: Razor blade technology

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Interlocutory records

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (A63−2 ) | National doc | 14. 06. 13 ( 21, 000) | Done | (A96−7 ) | Finding information | 14. 11. 26 ( ) | |
| (A62−1 ) | Examination request | 19. 12. 26 ( 85, 000) | Done | (A52−3 ) | Amendment | 19. 12. 26 ( ) | Done |
| (A96−7 ) | Finding information | 20. 01. 15 ( ) | | (A96−7 ) | Finding information | 20. 01. 15 ( ) | |
| (A971−007) | Search report | 22. 11. 05 ( ) | | (A971−011) | Usage status | 22. 11. 05 ( ) | |
| (A13−1 ) | Rejection reason | 22. 11. 12 (3505−22) | | (A60−1 ) | Time extension | 23. 02. 14 ( 2, 100) | Done |
| (A60−2 ) | Extension granted | 23. 02. 21 ( ) | A | (A96−7 ) | Finding information | 23. 02. 22 ( ) | |
| (A53 ) | Argument | 23. 03. 04 ( ) | Done | (A52−3 ) | Amendment | 23. 03. 04 ( ) | Done |
| (A96−7 ) | Finding information | 23. 03. 14 ( ) | | (A96−7 ) | Finding information | 23. 03. 14 ( ) | |
| (A02 ) | Rejection decision | 23. 09. 13 (3505− ) | | (A52−3 ) | Amendment | 24. 01. 13 ( ) | Done |
| (C60 ) | Demand | 24. 01. 13 ( ) | Done | (A91−1 ) | Reconsideration | 24. 01. 23 ( ) | |
| (C21 ) | Reconsideration notice | 24. 01. 24 (7088− ) | | (A01 ) | Patent grant | 24. 03. 02 (3505− ) | |
| (A61 ) | Registration payment | 24. 03. 28 ( ) | | | | | |

New application
Domestic priority (senior)
Domestic priority (junior)
IB interlocutory records

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (AIB31A ) | Priority document | 3. 09. 07 (00008878) | Done | (AIB349 ) | Int'l publication | 13. 09. 14 (00008878) | Done |
| (AIB3492) | Int'l ex officio | 13. 09. 14 (00003081) | Done | (AIB331 ) | Selection notice | 13. 11. 26 (00002984) | Done |
| (AIBC349) | Int'l publication | 14. 02. 14 (00008878) | Done | (AIB210 ) | I S R | 14. 02. 14 (00008878) | Done |
| (AIB338 ) | I P E R | 14. 10. 04 (00008878) | Done | | | | |



PACE-037178

Appeal case information

| | |
|---|---|
| Appeal No. | [2012－000717 ] |
| Appeal Type | [Trial to appeal rejection decision ] |
| Demand date | [2012. 01. 13 ] |
| Trial date | [ ] |
| Decision | [Registration decision by reconsideration ] |
| Finalization date | [2012. 02. 28 ] |

Name of Document: National documents

File No.: 13722801

Date Submitted: June 13, 2002

Addressee: Commissioner of the Japan Patent Office

Identification of the Application:
International Application No.: PCT/US01/06206
Application Type: Patent

Number of Claims: 30

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PACE-037180

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PACE-037181

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|---|---|
| Prepayment Ledger No.: | 087654 |
| Fees paid: | 21,000 yen |

List of Submitted Materials

| | | |
|---|---|---|
| Material Name: | Translation of the specification: | 1 |
| Material Name: | Translation of the abstract: | 1 |

Requirement for proof: Required

Name of Document: Specification

Title of the Invention: Razor blade technology

Claims

Claim 1

A razor blade comprising:

a substrate with a cutting blade defined by a sharpened tip and nearby surfaces,

a hard coating layer on said cutting blade,

a protective film layer of a chromium containing material on said hard coating layer, and

an outer layer of polytetrafluoroethylene coating said protective film layer.

Claim 2

The razor blade according to claim 1 wherein said hard coating is made of a carbon containing material.

Claim 3

The razor blade according to claim 2 wherein said carbon containing material comprises diamond.

Claim 4

The razor blade according to claim 2 wherein said hard carbon coating comprises a diamond-like carbon material.

Claim 5

The razor blade according to claim 2 wherein said hard carbon coating comprises amorphous diamond material.

Claim 6

The razor blade according to claim 1 wherein said protective film layer consists of chromium.

Claim 7

The razor blade according to claim 1 wherein said protective film layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

Claim 8

The razor blade according to claim 4 wherein said protective film layer consists of chromium.

Claim 9

The razor blade according to claim 7 wherein said alloy is a chromium platinum alloy.

Claim 10

The razor blade according to claim 1 further comprising an intermediate layer interposed between said substrate and said hard coating layer.

Claim 11

The razor blade according to claim 10 wherein said intermediate layer comprises niobium.

Claim 12

The razor blade according to claim 10 wherein said intermediate layer comprises a chromium containing material.

Claim 13

The razor blade according to any one of claim 6, 7, 8 or 9 wherein said protective film layer is compressively stressed.

Claim 14

The razor blade according to claim 1 wherein said polytetrafluoroethylene is Krytox LW1200.

Claim 15

The razor blade according to claim 4 wherein a niobium intermediate layer is interposed between said substrate and said hard coating.

Claim 16

The razor blade according to claim 8 wherein said polytetrafluoroethylene is Krytox LW1200.

Claim 17

The razor blade according to claim 1 wherein said hard coating layer has a thickness of less than 2,000 angstroms.

Claim 18

The razor blade according to claim 1 wherein said protective film layer has a thickness between 100 angstroms and 500 angstroms.

Claim 19

The razor blade according to claim 1 wherein said outer layer has a thickness between 100 angstroms and 5,000 angstroms.

Claim 20

The razor blade according to any one of claim 1, 8, 16 or 17 comprising a cutting blade whose rounding with repeated shaves is reduced as compared to when said protective film layer is absent.

Claim 21

In a razor comprising a handle, a housing connected to said handle, and at least one razor blade mounted in said housing,

a razor wherein said razor blade comprises

a substrate with a cutting blade defined by a sharpened tip and nearby surfaces,

a hard coating layer on said cutting blade,

a protective film layer of a chromium containing material on said hard coating layer, and

an outer layer of polytetrafluoroethylene coating over said protective film layer.

Claim 22

The razor according to claim 21 wherein said hard coating consists of a carbon containing material.

Claim 23

The razor according to claim 22 wherein niobium intermediate layer is interposed between said substrate and said hard coating.

Claim 24

The razor according to either claim 21 or 22 wherein said protective film layer consists of

chromium.

Claim 25

A method of manufacturing a razor blade comprising a step for preparing a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;

a step for adding a hard coat layer on said cutting blade;

a step for adding a protective film layer of a chromium containing material on said hard coating layer; and

a step for adding an outer layer of polytetrafluoroethylene coating over said protective film layer.

Claim 26

The method according to claim 25 wherein the step for adding said hard coating layer includes vapor depositing a carbon containing material.

Claim 27

The method according to claim 25 wherein the step for adding a layer of chromium containing material includes vapor depositing said chromium containing material.

Claim 28

The method according to claim 27 wherein said step for adding a layer of chromium containing material includes sputter deposition under conditions to provide a compressively stressed material.

Claim 29

The method according to claim 28 wherein said sputtering includes applying a DC bias to said [sic] target that is more negative than -50 volts or a comparable RF bias scheme.

Claim 30

The method according to claim 28 wherein said sputtering includes applying a DC bias to a target that is more negative than -200 volts or a comparable RF bias scheme.

Detailed Description of the Invention

0001

The invention relates to improvements to razors and razor blades.

0002

A razor blade is typically formed of a suitable substrate material such as stainless steel. A cutting blade is formed with a V-shape with an ultimate tip having a radius less than about 1,000 angstroms, e.g., about 200 - 300 angstroms. A hardened coating such as diamond, e.g., amorphous diamond, diamond-like carbon-(DLC), nitrides, carbides, oxides or ceramics is often used to improve strength, corrosion resistance and razor performance, maintaining needed strength while permitting thinner edges that lower the cutting resistance. Polytetrafluoroethylene (PTFE) outer layer is used to reduce friction. An intermediate of niobium or chromium containing material can aid to improve the bonding between the substrate, typically stainless steel, and a hard carbon coating, such as DLC. Examples of the structure of the cutting tip of the blade and the razor blade and manufacturing steps are described, for example, in U.S. Pat. Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591339; and PCT 92/03330, which are hereby incorporated by reference.

0003

In use, the ultimate tip of the edge having a hard coating and a polytetrafluoroethylene outer layer can become more rounded after repeated shaves such that, ordinarily, there is an increase in the tip radius and a perceived decrease in razor performance.

0004

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting blade defined by a sharpened tip and nearby surfaces, a hard coating layer on the cutting blade, a protective film layer of a chromium containing material on the hard coating layer, and a

polytetrafluoroethylene coating outer layer on the protective film layer.

0005

In another aspect, the invention features, in general, a razor blade including a handle, a razor head with a blade having a substrate with a cutting blade defined by a sharpened tip and nearby surfaces, a hard coating layer on the cutting blade, a protective film layer of a chromium containing material on the hard coating layer, and a polytetrafluoroethylene coating outer layer on the protective film layer.

0006

Particular embodiments of the invention may include one or more of the following features. In particular embodiments, the hard coating material can be made of carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides, carbides, oxides or other ceramics. The hard coating layer can have a thickness less than 2,000 angstroms. The protective film layer can be made of chromium or a chromium containing alloy compatible with polytetrafluoroethylene such as a chromium platinum alloy. The protective film layer can be between 100 and 500 angstroms thick. The blade can include an intermediate layer between the substrate and the hard coating layer. The intermediate layer can include niobium or a chromium containing material. The polytetrafluoroethylene can be Krytox LW1200 available from DuPont. The PTFE outer layer can be between 100 and 5000 angstroms thick.

0007

In another aspect, the invention features, in general, making a razor blade by preparing a substrate with a cutting blade defined by a sharpened tip and nearby surfaces, adding a hard coating layer on the cutting blade, adding a protective film layer of a chromium containing material on the hard coating layer, and adding an outer layer of polytetrafluoroethylene coating over the protective film layer.

0008



PACE-037188

Particular embodiments of the invention may include one or more of the following features. In particular embodiments, the layers can be added by physical vapor deposition (i.e., sputtering) or by chemical vapor deposition. The chromium containing layer, preferably chromium, can be sputter deposited under conditions that result in a compressively stressed coating. The sputter deposition of chromium containing materials can include applying a DC bias to the target that is more negative than -50 volts, preferably more negative than -200 volts. Alternatively an appropriate RF bias scheme can be used to achieve an equivalent chromium layer.

0009

Embodiments of the invention may include one or more of the following advantages. The use of a protective film layer of chromium provides improved adhesion of the polytetrafluoroethylene outer layer to the hard coating layer. The razor blade has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves. Reduced tip rounding minimizes the increase in cutting force thereby maintaining excellent razor performance. The razor blade has excellent razor characteristics from the first shave onwards.

0010

Other features and advantages of the invention will be apparent from the following description of a particular embodiment and from the claims.

0011

FIG. 1 is a vertical sectional view of a cutting blade portion of a razor blade. FIG. 2 is a perspective view of a razor including the FIG. 1 razor blade.

0012

Referring to FIG. 1, there is shown razor blade 10 including substrate 12, intermediate layer 14, hard coating layer 16, protective film layer 18, and outer layer 20. The substrate 12 is typically made of stainless steel (though other substrates can be employed) and has an ultimate



PACE-037189

edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side surfaces 22 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

0013

Intermediate layer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable intermediate layer material are niobium and chromium containing material. A particular intermediate layer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium intermediate layer.

0014

Hard coating layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides (e.g., boron nitride, niobium nitride or titanium nitride), carbides (e.g., silicon carbide), oxides (e.g., alumina, zirconia) or other ceramic materials. The carbon containing materials can be doped with other elements, such as tungsten, titanium or chromium by including these additives, for example in the target during application by sputtering. The materials can also incorporate hydrogen, e.g., hydrogenated DLC. Preferably coating layer 16 is made of diamond, amorphous diamond or DLC. A particular embodiment includes DLC less than 2,000 angstroms, preferably less than 1,000 angstroms. DLC layers and methods of deposition are described in U.S. Pat. No. 5,232,568. As described in the "Handbook of Physical Vapor Deposition (PVD)



PACE-037190

Processing," DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond.

0015

Protective film layer 18 is used to reduce the tip rounding of the hard coating edge and to facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Protective film layer 18 is preferably made of chromium containing material, e.g., chromium or chromium alloys that are compatible with polytetrafluoroethylene, e.g., CrPt. A particular protective film layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the protective film layer.

0016

Outer layer 20 is used to provide reduced friction and includes polytetrafluoroethylene and is sometimes referred to as a telomer. A particular polytetrafluoroethylene material is Krytox LW 1200 available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Pat. Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.

0017

Razor blade 10 is made generally according to the processes described in the above

referenced patents. A particular embodiment includes a niobium intermediate layer 14, DLC hard coating layer 16, chromium protective film layer 18, and Krytox LW1200 polytetrafluoroethylene outer coat layer. Chromium protective film layer 18 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium protective film layer which is believed to promote improved resistance to tip rounding while maintaining good razor performance. Blade 10 preferably has a tip radius of about 200-400 angstroms, measured by SEM after application of protective film layer 18 and before adding outer layer 20.

0018

Referring to FIG. 2, blade 10 can be used in razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Pat. No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes an interconnect member on which housing 116 is pivotally mounted at two arms 128. The interconnect member includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

0019



PACE-037192

In use, razor blade 10 has excellent razor characteristics from the first shave onwards. Blade 10 has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves provided by the protective film layer coating while maintaining excellent razor characteristics.

0020

Other embodiments of the invention are within the scope of the claims.

Brief Description of the Figures

FIG. 1 is a vertical sectional view of a cutting blade portion of a razor blade.

FIG. 2 is a perspective view of a razor including the FIG. 1 razor blade.



PACE-037193

Date received: June 13, 2002

Name of Document: Abstract

Abstract

The razor blade comprises a substrate, and the substrate comprises a cutting blade defined by a sharpened tip and nearby surfaces. The razor blade further comprises a hard coating layer on the cutting blade, a protective film layer of a chromium containing material on the hard carbon coating layer, and an outer layer of polytetrafluoroethylene coating said protective film layer.

Selected Figure: FIG. 1



PACE-037194

Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 50200862471 |
| Document Name: | National Documents |
| Manager: | Hideaki Miyamoto 3081 |
| Date Prepared: | November 25, 2002 |

Finding/Additional Information

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No additional pages



PACE-037196

Name of Document: Demand for Examination of Application

File No.: 13722860

Date Submitted: December 26, 2007

Addressee: Commissioner of the Japan Patent Office

Identification of the Application:
Application No.: Patent Application 2001-563289

Number of Claims: 11

Demandant:
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Name: The Gillette Company

Agent:
Identification No.: 100075812
Patent Attorney
Name: Kenji Yoshitake

Identification of Fees
Prepayment Ledger No.: 087654
Fees paid: 85,000 yen

# Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 50200862471 |
| Document Name: | Demand for Examination of Application |
| Manager: | Yachiyo Higa T088 |
| Date Prepared: | January 11, 2008 |

Finding/Additional Information

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PACE-037198

Name of Document: Amendment
File No.: 13722802
Date Submitted: December 26, 2007
Addressee: Commissioner of the Japan Patent Office
Identification of the Case:
Application No.: Patent Application 2001-563289
Amender:
Identification No.: 593093249
Name: The Gillette Company
Agent:
Identification No.: 100075812
Patent Attorney
Name: Kenji Yoshitake
Number of Claims Reduced by Amendment: 19
Amendment 1:
Name of Document to Be Amended: Specification
Name of Item to Be Amended: Claims
Method of Amendment: Revision
Substance of the Amendment:
Claims:

Claim 1. In a razor blade,
a razor blade comprising:
a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;
a hard coating layer disposed on said cutting blade;
a protective film layer of a chromium containing material on said hard coating layer; and
an outer layer of polytetrafluoroethylene coating over said protective film layer.

Claim 2. The razor blade according to claim 1 wherein said hard coating is made of a material containing carbon.

Claim 3. The razor blade according to claim 2 wherein said material containing carbon comprises diamond.

Claim 4. The razor blade according to claim 2 wherein said hard carbon coating comprises diamond-like carbon material.

Claim 5. The razor blade according to claim 2 wherein said hard carbon coating comprises amorphous diamond.

Claim 6. The razor blade according to claim 1 wherein said protective film layer consists of chromium.

Claim 7. The razor blade according to claim 1 wherein said protective film layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.



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Claim 8. The razor blade according to claim 1 further comprising an intermediate layer between said substrate and said hard coating layer.

Claim 9. The razor blade according to claim 8 wherein said intermediate layer comprises niobium.

Claim 10. The razor blade according to claim 8 wherein said intermediate layer comprises a chromium containing material.

Claim 11. The razor blade according to claim 6 wherein said protective film layer is compressively stressed.



PACE-037200

Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 50702690090 |
| Document Name: | Amendment |
| Manager: | Yachiyo Higa T088 |
| Date Prepared: | January 11, 2008 |

Finding/Additional Information

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| Name: | Kenji Yoshitake |



PACE-037201

# Search Report

## Bibliographic Matters

| | |
|---|---|
| Registered search agency name | Industrial Property Cooperation Center |
| Registered search agency code | 001 |

| | | | |
|---|---|---|---|
| Instructor name | | Instructor code | L096 |
| Searcher name | | Searcher code | KY49 |
| Record type | 161 | | |
| Theme code | 3C066 | | |
| Patent application No. | Patent Application 2001-563289 | | |
| Outsourcing Management No. | 2010119756 | | |
| Delivery type | 3 | 1: Delivery type 2: Dialogue style (domestic)<br>3: Dialogue style (overseas) | |
| Dialogue date | November 4, 2010 | | |
| Initial evaluation designation | 2 | 1: Regular 2: Initial evaluation | |
| Search date | October 5, 2010 | | |
| Search report preparation date | October 5, 2010 | | |
| Summary type | None | | |

1. Features of the present invention

Figure showing the features of the invention of the present application: Figure

Features of the invention of the present application:

Claim 1.

(a) A razor blade comprising:

a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;

a hard coating layer disposed on said cutting blade;

(b) a protective film layer of a chromium containing material on said hard coating layer; and an outer layer of polytetrafluoroethylene coating over said protective film layer.

Claim 2.

(c) The razor blade according to claim 1 wherein said hard coating is made of a material containing carbon.

Claim 3.

(d) The razor blade according to claim 2 wherein said material containing carbon comprises diamond.



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Claim 4.

(e) The razor blade according to claim 2 wherein said hard carbon coating comprises diamond-like carbon material.

Claim 5.

(f) The razor blade according to claim 2 wherein said hard carbon coating comprises amorphous diamond.

Claim 6.

(g) The razor blade according to claim 1 wherein said protective film layer consists of chromium.

Claim 7.

(h) The razor blade according to claim 1 wherein said protective film layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

Claim 8.

(i) The razor blade according to claim 1 further comprising an intermediate layer between said substrate and said hard coating layer.

Claim 9.

(j) The razor blade according to claim 8 wherein said intermediate layer comprises niobium.

Claim 10.

(k) The razor blade according to claim 8 wherein said intermediate layer comprises a chromium containing material.

Claim 11.

(l) The razor blade according to claim 6 wherein said protective film layer is compressively stressed.

2. Search logic equation

Date range: Through February 29, 2000

| No. | Claim No. | Theme code | Search logic equation | No. of hits |
|---|---|---|---|---|
| 1 | 1 - 11 | 3C066 | [B26B21/60] * [coating + protective film] (FW + full text) - ΣΥ | 20 |
| 2 | 1 - 11 | 3C066 | [B26B21/60] * [polytetrafluoroethylene + PTEF + outer layer] (FW + full text) - ΣΥ | 11 |
| 3 | 1 - 11 | 3C066 | [B26B21/60] - ΣΥ | 91 |
| 4 | 1 - 11 | 3C066 | (coating + protective film)/TX - ΣΥ | 32 |
| 5 | 1 - 11 | 3C066 | (polytetrafluoroethylene + PTEF + outer layer)/TX - ΣΥ | 4 |

Total of screening hits: 158

3. Screening search results (displayed for each presented reference)

| No. | Presented document type | Dialogue type additional reference type | Presented reference | Representative category | Equation No. |
|---|---|---|---|---|---|
| 1 | Patent reference | | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 | A | 1 |
| 2 | Patent reference | | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 | A | 1 |
| 3 | Patent reference | | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 | A | 2 |
| 4 | Patent reference | | Unexamined Patent Application Publication No.: H02-065891 | A | 2 |
| 5 | Patent reference | | Unexamined Patent Application Publication No.: H11-009857 | A | 1 |
| 6 | Patent reference | | U.S. Patent No. 03743551 specification | A | Remarks |
| 7 | Patent reference | | U.S. Patent No. 05669144 specification | A | Remarks |

Number of presented references: 7



PACE-037204

4. Screening search results (claim categorized method)

| Claim No. | Reference No. | Category | Relevant section | Description of differences or missing elements from the inventions of the present application or elements |
|---|---|---|---|---|
| 1 | 1 | A | a [P4, F3b'[ P5, F3 | Prior art razor blade comprising a main body part (substrate) with a cutting blade, outer layer of DLC (hard coating layer) and PTFE coating (outer layer).<br>---> No protective film layer containing chromium deposited over the hard coating layer. |
| | 2 | A | a [P4, F3b'[ P5, F3 | Prior art razor blade comprising a main body part (substrate) with a cutting blade, outer layer of DLC (hard coating layer) and PTFE coating (outer layer).<br>---> No protective film layer containing chromium deposited over the hard coating layer. |
| | 3 | A | a [P9, F5b'[ P9, F5 | Prior art razor blade comprising a main body part (substrate) with a cutting blade, outer layer of DLC (hard coating layer) and PTFE coating (outer layer).<br>---> No protective film layer containing chromium deposited over the hard coating layer. |
| | 4 | A | a [P3, F1b'[ P3, F1 | Prior art razor blade comprising a stainless steel substrate (base material), hard film of chromium or chromium nitride (hard coating layer) and PTFE coating (outer layer).<br>---> Although not described as a protective film, this is a Y2 reference if the hard film of chromium or chromium nitride is assumed to double as a protective film. |
| | 5 | A | b' [N3 | Prior art razor blade wherein PTFE with a thin chromium layer base is deposited on a cutting edge, increasing corrosion resistance of the blade.<br>---> Not deposited on a hard coating layer. |
| | 6 | A | a [N1b'[N1 | Prior art razor blade comprising a razor blade (cutting edge), chromium nitride (hard coating layer) and PTFE coating.<br>---> No protective film layer containing chromium deposited over the hard coating layer. |

| | | | | |
|---|---|---|---|---|
| | 7 | A | a [N1b'[N1 | Prior art razor blade comprising a stainless steel body (cutting edge), DLC (hard coating layer) and adherent telomer layer (PTFE coating).<br>---> No protective film layer containing chromium deposited over the hard coating layer. |
| 2, 3, 4 | 1 | A | [P4 | Prior art example of diamond-like carbon (DLC) |
| | 2 | A | [P4 | Prior art example of diamond-like carbon (DLC) |
| | 5 | A | [N11 | Prior art example of diamond-like carbon (DLC) |
| 5 | 5 | A | [N15 | Prior art example of amorphous diamond |
| 6 | 4 | A | g [P3, F1 | Prior art example of a hard film (protective film layer) of chromium or chromium nitride |
| 7 | 4 | A | h [P3, F1 | Prior art example of a hard film (protective film layer) of chromium or chromium nitride |
| 8 | 1 | A | i [P4, F3 | Prior art example comprising an intermediate layer between a base material and a hard coating layer |
| | 3 | A | i [P9, F6 | Prior art example comprising an intermediate layer between a base material and a hard coating layer |
| 9 | 1 | A | j [P4, F3 | Prior art example with a niobium intermediate layer |
| 10 | 2 | A | k' [P4 | Prior art example of a molybdenum intermediate layer<br>-----> No intermediate layer containing chromium |
| 11 | 3 | A | [P12 | Prior art example of a DLC film having high internal stress<br>-----> No description of a compressively stressed protective film layer |



PACE-037206

5. Remarks (for the searcher)

Search references 6 and 7 are international search Y references.

Outside Search Agency Usage Status Form

November 5, 2010

Registered search agency name: Industrial Property Cooperation Center
Search agency code: 001
Theme code: 3C066
Control No.: 2010119756
Application No.: Patent Application 2001-563289
Examiner: Masao Kanemoto 3505 3C00

First draft after delivery: Notice of Reasons for Rejection, Article 29(2)

Acceptance or not of report: Accepted
Evaluation: --

Presented references

| No. | Use | Dialog based addition | Presented reference name |
|---|---|---|---|
| 1 | O | - | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 |
| 2 | - | - | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 |
| 3 | - | - | Unexamined Patent Application Publication (Translation of PCT Application): H06-507100 |
| 4 | - | - | Unexamined Patent Application Publication No.: H02-065891 |
| 5 | O | - | Unexamined Patent Application Publication No.: H11-009857 |
| 6 | - | - | U.S. Patent No. 03743551 specification |
| 7 | - | - | U.S. Patent No. 05669144 specification |

Additional search done or not: Not done
Additional search search equation:
Number of additional references: 0

No. of self theme cited references: 0

No. of other theme cited references: 0

Dialog type search done or not: Done

Date of dialog type search: November 4, 2010

Remarks



PACE-037210

Notice of Reasons for Rejection

| | |
|---|---|
| Patent Application No.: | Patent Application No. 2001-563289 |
| Date Drafted: | November 5, 2010 |
| Patent Office Examiner: | Masao Kanemoto 3505 3C00 |
| Agent for the Applicant: | Kenji Yoshitake (and 5 others) |
| Applicable provisions: | Patent Act, Article 29(2) |

This application shall be rejected for the reason(s) mentioned below. If the applicant has any argument against the reason(s), such argument shall be submitted within 3 months of the dispatching date of this notice.

Reason(s)

The inventions according to the claims described below of the subject application shall not be granted a patent under the provisions of Article 29(2) of the Patent Act since the inventions could easily have been made by those with a common knowledge in the technical field to which the invention belongs on the basis of inventions that were described in a publication that was distributed or made publicly available through an electric telecommunication line in Japan or a foreign country prior to the filing of the subject patent application.

Note (See "List of References and the Like" for a list of references)

- Claims 1 through 10
- References 1 and 2

Claims 1 and 6:

The invention described as prior art in reference 1 discloses (see paragraph 0003, etc.) a razor blade disposed with a protective film layer (e.g., a thin chromium layer) to an outer layer of PTFE.

Also, the inventions described in embodiments of references 1 and 2 disclose a substrate with a cutting blade defined by a sharpened tip and nearby surfaces, a hard coating layer disposed on said cutting blade, and an outer layer of polytetrafluoroethylene coating over said hard coating layer (see *inter alia* paragraph 0015 of reference 1; line 4, upper right column, page 4 through line 6, lower left column, page 4 of reference 2; lines 11 and 12, upper right column, page 5 of reference 2; and FIG. 3 of reference 2).

This means that it would have been an easy matter for those skilled in the art to arrive at applying the invention described as prior art in reference 1 to the razor blade

invention that is described in the embodiments of references 1 and 2.

Claims 2 through 4:

The hard coating layer that is described in the inventions of references 1 and 2 is a DLC.

Claim 5:

The hard coating layer of the invention that is described in reference 1 comprises an amorphous diamond material.

Claim 7:

In applying the invention described as prior art in reference 1 to the razor blade invention that is described in the embodiments of references 1 and 2, it would have been an easy matter for those skilled in the art to arrive at the use of a protective film layer containing an alloy that is compatible with PTFE.

Claims 8 and 9:

The razor blade of the invention described in reference 2 comprises a substrate, a hard coating layer and an intermediate layer comprising niobium.

Claim 10:

The razor blade of the invention described in references 1 and 2 comprises an intermediate layer consisting of molybdenum, which belongs to the chromium group.

This means that it would have been an easy matter for those skilled in the art to arrive at a chromium containing material as the intermediate layer in the invention described in the embodiments of references 1 and 2.

Thus, the inventions according to claims 1 through 10 of the present application could have been easily invented by those skilled in the art on the basis of the inventions described in references 1 and 2.

List of Cited References

1. Unexamined Patent Application Publication No. H11-009857
2. Unexamined Patent Application Publication (Translation of PCT Application) No. H06-507100

Note:

(1) If the specification is amended, the amended portion must be underlined (Patent Act



PACE-037212

Regulations Format 13, note 6).
(2) Amendments are limited to the scope of matters described by the figures and the specification of the original patent application. Each amended item must be accompanied in the Argument by a description of the reasons for its permissibility by citing to specific sections of support in the specification and the like in the original application.
(3) At the present moment, no reason for rejection is found for the invention according to claim 11, which is a claim that is not addressed by the Notice of Reasons for Rejection. If a reason for rejection is newly found, the applicant will be notified of the reason for rejection.

Record of Results of Prior Art Literature Search

- Fields searched: IPC B26B21/00-21/60

The records of the result of the prior art literature search do not constitute a part of the reasons for rejection.

Direct all questions concerning the substance of this notice of rejection to:

Masao Kanemoto
Manufacturing Equipment
Second Patent Examination Dept.
Tel: 03 (3581) 1101 extension 3324
Fax: 03 (3501) 0530

| Director-General/Deputy | Chief Examiner/Deputy | Examiner | Deputy Examiner |
|---|---|---|---|
| | Makoto Yagi | Masao Kanemoto | |
| | 9348 | 3505 | |



PACE-037213

| | |
|---|---|
| Name of Document: | Request for Extension of Time |
| File No.: | 13722888 |
| Date Submitted: | February 14, 2011 |
| Addressee: | Commissioner of the Japan Patent Office |

Identification of the Case:
Application No.: Patent Application 2001-563289

Requester:
Identification No.: 593093249
Name: The Gillette Company

Agent:
Identification No.: 100075812
Patent Attorney
Name: Kenji Yoshitake

Dispatch No.: 808295

Nature of the Request: Regarding the above case, an extension of time of 1 month is requested for the translation of procedural documents.

Identification of Fees
Prepayment Ledger No.: 087654
Fees paid: 2,100 yen

Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 51100303039 |
| Document Name: | Request for Extension of Time |
| Manager: | Designated office, third chief 0033 |
| Date Prepared: | February 21, 2011 |

Finding/Additional Information

Demandant:

| | |
|---|---|
| Identification No.: | 593093249 |
| Address: | IP/Legal Patent Department 3E,<br>World Shaving Headquarters,<br>One Gillette Park,<br>Boston, MA, U.S.A. |
| Name: | The Gillette Company |

Agent: Requester

| | |
|---|---|
| Identification No.: | 100075812 |
| Address: | Kyowa Patent and Law Office<br>3-2-3 Marunouchi, Chiyoda-ku, Tokyo |
| Name: | Kenji Yoshitake |

Name of Document: Argument
File No.: 13722802
Date Submitted: March 4, 2011
Addressee: Commissioner of the Japan Patent Office
Identification of the Case:
Application No.: Patent Application 2001-563289
Patent Applicant:
Identification No.: 593093249
Name: The Gillette Company
Agent:
Identification No.: 100075812
Patent Attorney
Name: Kenji Yoshitake
Dispatch No.: 808295
Substance of the Argument:
(1) Substance of the reasons for rejection

The examiner has found that the inventions according to claims 1 through 10 of the present application cannot be granted a patent under the provisions of Article 29(2) of the Patent Act since the inventions could have been easily made on the basis of the inventions described in references 1 and 2 below.

Cited reference 1: Unexamined Patent Application Publication No. H11-009857

Cited reference 2: Unexamined Patent Application Publication (Translation of PCT Application) No. H06-50710

In response, the patent applicant argues as follows and also amends the claims in the specification.

The amendments to the claims are based on the figures and description in the specification of the original application (*inter alia*, claim 2 and paragraphs 0006 and 0014 of the specification before the amendment).

(2) Patent applicant's argument

(i) Characteristics of the invention of the present application

The gist of the invention of the present application is as described in claim 1 of the claims as amended by the attached Amendment, but the features of particular prominence are as follows:

(a) The fact that a protective film layer of a chromium containing material is disposed on a hard coating layer made of carbon;

(b) The fact that the protective film layer is coated with an outer layer of polytetrafluoroethylene.

With the invention of the present application, the combination of afore-described features (a) and (b) results in the interposition of a protective film layer of chromium between the hard coating layer made of carbon and the outer layer of polytetrafluoroethylene. This improves the adhesion of the outer polytetrafluoroethylene layer to the hard coating layer. Furthermore, the hard coating layer improves the edge strength of the razor blade, which reduces the rounding of the tip under repeated shaves, suppresses the increase in resistance to cutting to the maximum extent possible and maintains an exceptional razor blade performance. In other words, the razor blade can provide and maintain an exceptional razor blade property from the very first shave. (See paragraphs 0008 and 0015 of the specification of the present application.)

(ii) Comparison against the cited references

Reference 1:

Reference 1, which is titled "Razor blade and its manufacturing method," contains no description of afore-described features (a) and (b) of the invention of the present application.

To explain, reference 1 contains the following description, "... by depositing an inner coating of a suitable thickness onto the edge. The coating consists of a compatible metal [sic] including oxides, carbides, borides, metals and any combinations thereof, but preferred metals [sic] include ceramics, chromium, chromium/platinum and chrome nitride." (See paragraph 0014 of the specification of reference 1.)

Reference 1 also contains the following description: "The edge is coated with an outer coating of a thin film of a non-polymeric material with a very low coefficient of friction. ... Preferred materials having such a low coefficient of friction are amorphous diamond, diamond-like carbon (DLC), molybdenum disulfide, or any other similar material." (See paragraph 0015 of reference 1.)

Reference 1 further contains the following description: "In an especially preferred embodiment, the blade edge is first coated with a thin film having a low coefficient of friction, such as amorphous diamond, and then with a lubricious polymer such as low molecular weight PTFE or KRYTOX 1000 to provide a shave exhibiting minimal cut force." (See paragraph 0015 of reference 1.)

In this way, with reference 1, the cutting blade is coated with an inner coating containing chromium, an outer coating containing diamond-like carbon (DLC) and a lubricious polymer coating of PTFE, in this sequence.

However, reference 1 does not contain any description or suggestion to the effect that a chromium containing coating is interposed between the coating containing diamond-like carbon (DLC) and the lubricious polymer coating of PTFE. Moreover, it is utterly impossible on the basis of such reference 1 to read the concept of the invention of the present application of interposing a chromium containing coating between the coating containing diamond-like carbon (DLC) and the lubricious polymer coating of PTFE to improve the adhesion between the coating containing diamond-like carbon (DLC) and the lubricious polymer coating of PTFE and maintain the razor properties.

In contrast to this, the invention of the present application is characterized by disposing a protective film layer of a chromium containing material on the hard coating layer made of carbon (afore-described feature (a) of the invention of the present application) and coating the protective film layer with an outer layer of polytetrafluoroethylene (afore-described feature (b) of the invention of the present application). On this point, the two are completely different in their configuration.

Reference 2:

Reference 2, which is titled "Improvements related to razor blade," contains no description of afore-described features (a) and (b) of the invention of the present application. To explain, reference 2 contains the following description: "... an outer layer 60 of diamond-like carbon (DLC) is present on top of intermediate layer 58 of niobium ... Disposed on layer 60 is adhesive telomer 72 having a substantial layered thickness but whose thickness is reduced to a monolayer during the first shave." (See lines 4 through 15, lower left column, page 4 of the specification of reference 2.)

Reference 2 also contains the following description: "... next, polytetrafluoroethylene coating 72 ..." (See lines 11 and 12, upper right column, page 5 of the specification of reference



PACE-037217

2.)

In this way, with reference 2, disposed on top of main body part 50 are a niobium intermediate layer 58, a diamond-like carbon (DLC) outer layer 60 and a polytetrafluoroethylene coating 72, in this sequence.

However, reference 2 does not contain any description or suggestion to the effect that a chromium protective film layer is interposed between the diamond-like carbon (DLC) outer layer 60 and polytetrafluoroethylene coating 72. Moreover, it is utterly impossible on the basis of such reference 2 to read the concept of the invention of the present application of interposing a chromium protective film layer between the diamond-like carbon (DLC) outer coating 60 and the polytetrafluoroethylene coating 72 to improve the adhesion between the diamond-like carbon (DLC) outer coating 60 and the polytetrafluoroethylene coating 72 and maintain the razor properties.

In contrast to this, the invention of the present application is characterized by disposing a protective film layer of a chromium containing material on the hard coating layer made of carbon (afore-described feature (a) of the invention of the present application) and coating the protective film layer with an outer layer of polytetrafluoroethylene (afore-described feature (b) of the invention of the present application). On this point, the two are completely different in their configuration.

(3) Conclusion

As afore-described, the invention of the present application differs from the inventions described in references 1 and 2 in terms of their configuration and their operation and effects. Furthermore, the operation and effects are different even when references 1 and 2 are combined. Thus, it is the applicant's view that the invention of the present application could not have been easily invented on the basis of the inventions described in references 1 and 2.

It is also noted here that the European patent application that is the counterpart to the present application was granted a patent despite the counterpart publication (EP0,884,142) to reference 1 being cited.

The applicant requests that the above points be considered and that a patent be granted.

Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 51100456026 |
| Document Name: | Argument |
| Manager: | Designated office, third chief 0033 |
| Date Prepared: | March 11, 2011 |

Finding/Additional Information

Patent Applicant:

| | |
|---|---|
| Identification No.: | 593093249 |
| Address: | IP/Legal Patent Department 3E,<br>World Shaving Headquarters,<br>One Gillette Park,<br>Boston, MA, U.S.A. |
| Name: | The Gillette Company |

Agent: Requester

| | |
|---|---|
| Identification No.: | 100075812 |
| Address: | Kyowa Patent and Law Office<br>3-2-3 Marunouchi, Chiyoda-ku, Tokyo |
| Name: | Kenji Yoshitake |

Name of Document: Amendment
File No.: 13722803
Date Submitted: March 4, 2011
Addressee: Commissioner of the Japan Patent Office
Identification of the Case:
Application No.: Patent Application 2001-563289
Amender:
Identification No.: 593093249
Name: The Gillette Company
Agent:
Identification No.: 100075812
Patent Attorney
Name: Kenji Yoshitake
Number of Claims Reduced by the Amendment: 1
Amendment 1:
Name of Document to Be Amended: Specification
Name of Item to Be Amended: Claims
Method of Amendment: Revision
Substance of the Amendment:
Claims:

Claim 1. In a razor blade,
a razor blade comprising:
a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;
a hard coating layer disposed on said cutting blade;
a protective film layer of a chromium containing material on said hard coating layer;
an outer layer of polytetrafluoroethylene coating over said protective film layer; wherein
said hard coating is a made of a carbon containing material.

Claim 2. The razor blade according to claim 1 wherein said carbon containing material comprises diamond.

Claim 3. The razor blade according to claim 1 wherein said hard carbon coating comprises diamond-like carbon material.

Claim 4. The razor blade according to claim 1 wherein said hard carbon coating comprises amorphous diamond material.

Claim 5. The razor blade according to claim 1 wherein said protective film layer consists of chromium.

Claim 6. The razor blade according to claim 1 wherein said protective film layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

Claim 7. The razor blade according to claim 1 further comprising an intermediate layer between said substrate and said hard coating layer.

Claim 8. The razor blade according to claim 7 wherein said intermediate layer comprises niobium.

Claim 9. The razor blade according to claim 7 wherein said intermediate layer comprises a chromium containing material.



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Claim 10. The razor blade according to claim 5 wherein said protective film layer is compressively stressed.



PACE-037221

# Finding/Additional Information

| | |
|---|---|
| Patent Application No.: | Patent Application 2001-563289 |
| Receipt No.: | 51100456028 |
| Document Name: | Amendment |
| Manager: | Designated office, third chief 0033 |
| Date Prepared: | March 11, 2011 |

Finding/Additional Information

Amender:

| | |
|---|---|
| Identification No.: | 593093249 |
| Address: | IP/Legal Patent Department 3E,<br>World Shaving Headquarters,<br>One Gillette Park,<br>Boston, MA, U.S.A. |
| Name: | The Gillette Company |

Agent: Requester

| | |
|---|---|
| Identification No.: | 100075812 |
| Address: | Kyowa Patent and Law Office<br>3-2-3 Marunouchi, Chiyoda-ku, Tokyo |
| Name: | Kenji Yoshitake |



PACE-037222

Decision of Rejection

| | |
|---|---|
| Patent Application No.: | Patent Application No. 2001-563289 |
| Date Drafted: | September 8, 2011 |
| Patent Office Examiner: | Masao Kanemoto 3505 3C00 |
| Title of the Invention: | Razor Blade Technology |
| Patent Applicant: | The Gillette Company |
| Agent for the Applicant: | Kenji Yoshitake (and 5 others) |

This application shall be rejected for the reason(s) mentioned in the Notice of Reasons for Rejection dated November 5, 2010.

The Argument and the Amendment were considered, but no basis has been found to overturn the reasons for rejection.

Remarks

Regarding claims 1 through 10:

In the Amendment dated March 4, 2011, the applicant amended to delete the former claim 1 and to make the former claim 2 become the new claim 1.

In the Argument of the same date, the applicant argued that the inventions described in references 1 and 2 do not describe or suggest a chromium protective film layer that is interposed between the DLC layer and the PTFE layer.

However, in regards to claim 1, reference 1 states, "Most razor blades have a thin layer of chromium on the cutting edge to increase the blade's corrosion resistance and to provide a good base for the application of a lubricating polymer such as polytetrafluoroethylene (PTFE)" (paragraph 0003). This description is found to mean that a thin chromium layer is appropriate as a base layer for a PTFE layer (invention A).

As the applicant states in the Argument, the inventions described in references 1 and 2 disclose disposing a PTFE layer on a DLC layer (invention B).

This means that it would have been an easy matter for those skilled in the art to arrive at interposing a thin chromium layer between the DLC layer and the PTFE layer.

As for the other claims, the applicant is requested to refer to the aforesaid Notice of Reasons for Rejection.

For the above reasons, the applicant's argument is not accepted.

This decision may be appealed by filing a demand for trial with the Commissioner of the Patent Office within 3 months (4 months for overseas parties) of the date of service of the

certified copy of this decision (Article 121(1) of the Patent Act).

Notification based on Article 46(2) of the Administrative Case Litigation Act:

Action for revocation cannot be filed against this decision. An action for revocation can only be filed against a decision that is rendered in a trial appealing this decision (Article 178(6) of the Patent Act).

Notes regarding amendments made with the demand for trial:

(1) If the specification is amended, the amended portion must be underlined (Patent Act Regulations Format 13, note 6).

(2) Amendments are limited to the scope of matters described in the figures and the specification of the original patent application. Amendments to claims are limited to deletion of claims, narrowing of claims, correction of typographical errors and clarification of indefinite language (limited to items pointed out in the reasons for rejection). Furthermore, each amended item must be accompanied in the Argument by a description of the reasons for its permissibility by citing to specific sections of support in the specification and the like in the original application.

| Director-General/Deputy | Chief Examiner/Deputy | Examiner | Deputy Examiner |
|---|---|---|---|
| | Narihiko Tanaka | Masao Kanemoto | |
| | 3110 | 3505 | |

Name of Document: Amendment

File No.: 13722804

Date Submitted: January 13, 2012

Addressee: Commissioner of the Japan Patent Office

Identification of the Case:
Date of Demand for Trial: January 13, 2012
Application No.: Patent Application 2001-563289

Amender:
Identification No.: 593093249
Name: The Gillette Company

Agent:
Identification No.: 100117787
Patent Attorney
Name: Hirohito Katsunuma

Number of Claims Reduced by the Amendment: 1

Amendment 1:
Name of Document to Be Amended: Specification
Name of Item to Be Amended: Claims
Method of Amendment: Revision
Substance of the Amendment:

Claims:

Claim 1. In a razor blade,

a razor blade comprising:

a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;

a hard coating layer disposed on said cutting blade;

a protective film layer of a chromium containing material on said hard coating layer;

an outer layer of polytetrafluoroethylene coating over said protective film layer; wherein

said hard coating is a made of a carbon containing material; <u>and</u>

<u>said protective film layer is compressively stressed.</u>



PACE-037225

Claim 2. The razor blade according to claim 1 wherein said carbon containing material comprises diamond.

Claim 3. The razor blade according to claim 1 wherein said hard carbon coating comprises diamond-like carbon material.

Claim 4. The razor blade according to claim 1 wherein said hard carbon coating comprises amorphous diamond material.

Claim 5. The razor blade according to claim 1 wherein said protective film layer consists of chromium.

Claim 6. The razor blade according to claim 1 wherein said protective film layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

Claim 7. The razor blade according to claim 1 further comprising an intermediate layer between said substrate and said hard coating layer.

Claim 8. The razor blade according to claim 7 wherein said intermediate layer comprises niobium.

Claim 9. The razor blade according to claim 7 wherein said intermediate layer comprises a chromium containing material.

Name of Document: Demand for Trial

File No.: 13722880

Date Submitted: January 13, 2012

Addressee: Commissioner of the Japan Patent Office

Identification of the Case:
Application No.: Patent Application 2001-563289
Type of Trial: Trial Against Decision of Rejection

Number of Claims: 9

Trial Demandant:
Identification No.: 593093249
Name: The Gillette Company

Agent:
Identification No.: 100117787
Patent Attorney
Name: Hirohito Katsunuma

Selected Agent:
Identification No.: 100091982
Patent Attorney
Name: Hiroyuki Nagai

Selected Agent:
Identification No.: 100107537
Patent Attorney
Name: Katsuomi Isogai

Selected Agent:
Identification No.: 100105795
Patent Attorney
Name: Satoshi Nazuka

Name of document: Demand for Trial　　　　　　　　Date received: January 13, 2012
Patent: 2001-563289

Selected Agent:
Identification No.: 100096895
Patent Attorney
Name: Junpei Okada

Selected Agent:
Identification No.: 100106655
Patent Attorney
Name: Hideyuki Mori

Selected Agent:
Identification No.: 100127465
Patent Attorney
Name: Yukihiro Hotta

Selected Agent:
Identification No.: 100150717
Patent Attorney
Name: Kazuya Yamashita
Telephone No.: 03-3211-2320
Contact: Staff in charge

Identification of Fees
Prepayment Ledger No.: 425926
Fees paid: 99,000

Relief Sought: A decision annulling the original decision and granting a patent to the present application.

Reasons for the Demand:
(1) History of the Procedure:

| | |
|---|---|
| Submission of national phase document: | June 13, 2002 |
| Amendment: | December 26, 2007 |
| Notice of Reasons for Rejection: | November 5, 2010 |
| Amendment: | March 4, 2011 |

| | |
|---|---|
| Argument: | March 4, 2011 |
| Decision of Rejection: | September 8, 2011 |
| Service of Certified Copy of Above: | September 13, 2011 |

(2) Gist of the Decision of Rejection

(2-1) The inventions related to claims 1 through 9 of the present application were rejected under the provisions of Article 29(2) of the Patent Act since the inventions could have been easily invented on the basis of the inventions described in references 1 and 2 identified below.

1. Unexamined Patent Application Publication No. H11-009857
2. Unexamined Patent Application Publication (Translation of PCT Application) No. H06-507100

(2-2) The reason is shown below.

> In the Amendment dated March 4, 2011, the applicant amended to delete the former claim 1 and to make the former claim 2 become the new claim 1.
> In the Argument of the same date, the applicant argued that the inventions described in references 1 and 2 do not describe or suggest a chromium protective film layer that is interposed between the DLC layer and the PTFE layer.
> However, in regards to claim 1, reference 1 states, "Most razor blades have a thin layer of chromium on the cutting edge to increase the blade's corrosion resistance and to provide a good base for the application of a lubricating polymer such as polytetrafluoroethylene (PTFE)" (paragraph 0003). This description is found to mean that a thin chromium layer is appropriate as a base layer for a PTFE layer (invention A). As the applicant states in the Argument, the inventions described in references 1 and 2 disclose disposing a PTFE layer on a DLC layer (invention B).
> This means that it would have been an easy matter for those skilled in the art to arrive at interposing a thin chromium layer between the DLC layer and the PTFE layer.
> As for the other claims, the applicant is requested to refer to the aforesaid Notice of Reasons for Rejection.
> For the above reasons, the applicant's argument is not accepted.

(2-3) As for the invention related to claim 10, although the office found no reason for its

rejection, this was not explicitly stated in the certified copy of the Decision of Rejection dated September 8, 2011. Through a telephone conversation held on September 22, 2011 with Examiner Kanemoto who had drafted the Decision of Rejection, the applicant has confirmed that the examiner had failed to include this description in the certified copy of the Decision of Rejection.

(2-4) In response, the applicant amended the claims in the specification and also argued as follows.

(3) Overview of the Amendment

By way of the Amendment of the same date as the Demand for Trial, the applicant amended claim 1 as follows:

> Claim 1.
> In a razor blade,
> a razor blade comprising:
> a substrate with a cutting blade defined by a sharpened tip and nearby surfaces;
> a hard coating layer disposed on said cutting blade;
> a protective film layer of a chromium containing material on said hard coating layer; and
> an outer layer of polytetrafluoroethylene coating over said protective film layer; wherein
> said hard coating is a made of a carbon containing material; and
> said protective film layer is compressively stressed.

In other words, claim 10 for which no reason for rejection had been found as of yet was merged with claim 1 prior to the amendment.

Needless to say, the above amendment is based on the description found in the figures and specification in the original application and satisfies the requirements under Article 17-2-(3)) of the Patent Act.

Furthermore, the purpose of the above amendment is "to narrow the claims" as defined in Article 17-2-(4)-(ii) of the Patent Act.

(4) Argument by the Applicant

The applicant has decided to seek a patent by amending the claims along the findings made by the examiner.



PACE-037230

To explain, claim 10 for which no reason for rejection had been found as of yet was merged with claim 1 prior to the amendment to create a new independent claim 1, and claim 10 prior to the amendment was deleted.

Although claim 10 prior to the amendment was a dependent claim of claim 5 prior to the amendment, it has been confirmed with Examiner Kanemoto that even if claim 5 prior to the amendment were not merged with claim 1, no reason is found as of now to reject claim 1 as amended.

Claim 1 as amended improves the adhesion between the hard coating made of carbon and the outer layer of polytetrafluoroethylene. Furthermore, the hard coating layer improves the edge strength of the razor blade, which reduces the rounding of the tip under repeated shaves, suppresses the increase in cutting resistance to the maximum extent possible and maintains an exceptional razor blade performance. In other words, the razor blade can provide and maintain an exceptional razor blade property from the very first shave. (See paragraphs 0009, 0015 and 0017 of the specification of the present application.)

The applicant believes that claims 1 through 9 as amended should be granted a patent.

(5) Conclusion

As stated above, the applicant believes that a patent should be granted to the invention of the present application and requests a decision to grant a patent after considering the above.

Although the applicant believes that a patent should be granted to the invention of the present application, if the appeal examiner believes that the reason for rejection is still not resolved, the applicant would request an interview to resolve the matter.

In that event, please direct your communication to below:

Patent Attorney Kazuya Yamashita,



PACE-037231

Name of document: Demand for Trial
Patent: 2001-563289

Date received: January 13, 2012

Kyowa Patent and Law Office

Telephone: 3211-2320

Fax: 3211-1710

List of Submitted Materials

General Power of Attorney No.: 0816611

Name of document: Notice of Reconsideration by Examiner Before Appeal
Patent: 2001-563289

Notice of Reconsideration by Examiner Before Appeal

January 23, 2012
Commissioner of the Japan Patent Office

| | |
|---|---|
| Trial Demand No.: | Appeal 2012-717 |
| (Patent Application No.: | (Patent Application 2001-563289) |
| Demandant: | The Gillette Company |
| Agent: | Patent attorney Hirohito Katsunuma (and 7 others) |

In regards to the request for trial against a decision of rejection, this is to notify you that an examiner has been directed to examine the application pursuant to Article 162 of the Patent Act.

Trial Court Clerk: Ryoichi Makiguchi 7088

# Decision to Grant a Patent

| | |
|---|---|
| Patent Application No.: | Patent Application No. 2001-563289 |
| Date Drafted: | February 28, 2012 |
| Patent Office Examiner: | Masao Kanemoto 3505 3C00 |
| Title of the Invention: | Razor Blade Technology |
| Number of Claims: | 9 |
| Patent Applicant: | The Gillette Company |
| Agent for the Applicant: | Hirohito Katsunuma (and 7 others) |

Reconsideration by the Examiner Before Appeal:

The original decision is annulled.

There being no reason for rejection, a patent shall be granted to the application.

| | | | |
|---|---|---|---|
| Director-General/Deputy | Chief Examiner/Deputy | Examiner | Deputy Examiner |
| | Takaaki Ishii | Masao Kanemoto | Hiroyuki Nakano |
| | 9337 | 3505 | 4418 |

1. Type of application: Regular
2. References: Yes
3. Application of Article 30 of the Patent Act: No
4. Change in title of the invention: No
5. International patent classification (IPC): B26B 21/60
6. Deposited bacteria
7. Description not to allow

Reference Information

Patent Application No.: Patent Application 2001-563289

1. Field searched (IPC, database name)
   B26B 21/00-21/60

2. Reference patents
   - Unexamined Patent Application Publication No. H11-009857 (JP, A)
   - Unexamined Patent Application Publication (Translation of PCT Application) No. H06-507100 (JP, A)
   - United States Patent No. 5795648 (US, A)

3. Reference publications



PACE-037236

/

REC'D 17 MAY 2001
WIPO PCT

PI 390943

# THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

**UNITED STATES DEPARTMENT OF COMMERCE**
**United States Patent and Trademark Office**

**May 11, 2001**

**THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE UNDER 35 USC 111.**

3

**APPLICATION NUMBER:** ***09/515,421***
**FILING DATE:** ***February 29, 2000***
**PCT APPLICATION NUMBER:** *PCT/US01/06206*

(L)60101520570

**By Authority of the**
**COMMISSIONER OF PATENTS AND TRADEMARKS**

L. Edelen

**L. EDELEN**
**Certifying Officer**

**PRIORITY DOCUMENT**
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)



PACE-037237

03-01-00

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1855-1930

W.K. Richardson
1859-1951

BOSTON
DELAWARE
NEW YORK
SAN DIEGO
SILICON VALLEY
TWIN CITIES
WASHINGTON, DC

February 29, 2000

Attorney Docket No.: 00216-483001

**Box Patent Application**
Assistant Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicant: NEVILLE SONNENBERG, ANDREW ZHUK, CHARLES WHITE, STEVEN HAHN AND COLIN CLIPSTONE

Title: RAZOR BLADE TECHNOLOGY

Enclosed are the following papers, including those required to receive a filing date under 37 CFR 1.53(b):

| | Pages |
|---|---|
| Specification | 5 |
| Claims | 4 |
| Abstract | 1 |
| Declaration | [To be Filed at a Later Date] |
| Drawing(s) | 1 |

Enclosures:
— Postcard.

| | |
|---|---|
| Basic filing fee | $690 |
| Total claims in excess of 20 times $18 | $306 |
| Independent claims in excess of 3 times $78 | $78 |
| Fee for multiple dependent claims | $260 |
| Total filing fee: | $1334 |

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EL228033446

I hereby certify under 37 CFR §1.10 that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addressee with sufficient postage on the date indicated below and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Date of Deposit: February 29, 2000

Signature: Samantha Bell

Typed or Printed Name of Person Signing Certificate: Samantha Bell



PACE-037238

FISH & RICHARDSON P.C.

3

Assistant Commissioner for Patents
February 29, 2000
Page 2

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PACE-037239

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Attorney Docket No. 00216-483001

Razor Blade Technology

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and polytetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

Summary of the Invention

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene

09951525 - 090701



PACE-037240

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
**WO 01/64406 A2**

(51) International Patent Classification[7]: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,421 29 February 2000 (29.02.2000) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/515,421 (CON)
Filed on 29 February 2000 (29.02.2000)

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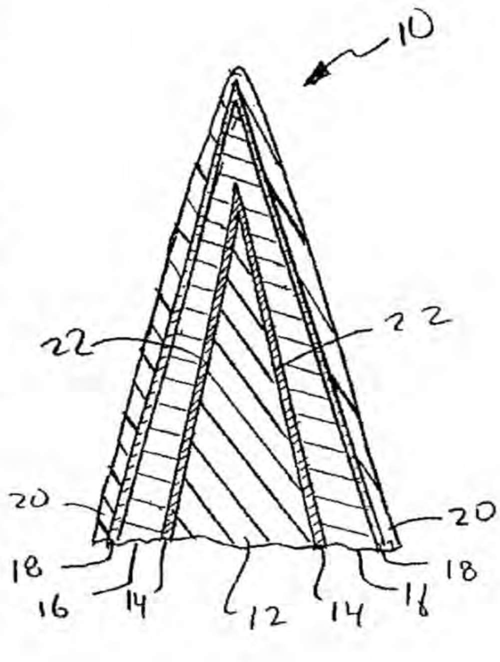
(74) Agents: **GALLOWAY, Peter, D.**; Ladas & Parry, 26 West 61st Street, New York, NY 10023 et al. (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

*[Continued on next page]*

(54) Title: RAZOR BLADE TECHNOLOGY




(57) Abstract: A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

**WO 01/64406 A2**



PACE-037241

DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

**(84) Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *without international search report and to be republished upon receipt of that report*

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# RAZOR BLADE TECHNOLOGY

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond; amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and poly-tetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetra-fluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

Particular embodiments of the invention may include one or more of



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the following features. In particular embodiments, the hard coating material can be made of carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides, carbides, oxides or other ceramics. The hard coating layer can have a thickness less than 2,000 angstroms. The overcoat layer can be made of chromium or a chromium containing alloy compatible with polytetrafluoroethylene such as a chromium platinum alloy. The overcoat layer can be between 100 and 500 angstroms thick. The blade can include an interlayer between the substrate and the layer of hard coating. The interlayer can include niobium or a chromium containing material. The polytetrafluoroethylene can be Krytox LW1200 available from DuPont. The PTFE outer layer can be between 100 and 5000 angstroms thick.

In another aspect, the invention features, in general, making a razor blade by providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets, adding a layer of hard coating on the cutting edge, adding an overcoat layer of a chromium containing material on the layer of hard coating, and adding an outer layer of polytetrafluoroethylene coating over the overcoat layer.

Particular embodiments of the invention may include one or more of the following features. In particular embodiments the layers can be added by physical vapor deposition (i.e., sputtering) or by chemical vapor deposition. The chromium containing layer, preferably chromium, can be sputter deposited under conditions that result in a compressively stressed coating. The sputter deposition of chromium containing materials can include applying a DC bias to the target that is more negative than -50 volts, preferably more negative than -200 volts. Alternatively an appropriate RF bias scheme can be used to achieve an equivalent chromium layer.

Embodiments of the invention may include one or more of the following advantages. The use of a chromium containing overcoat layer provides improved adhesion of the polytetrafluorethylene outer layer to the hard coating layer. The razor blade has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves. Reduced tip rounding minimizes the increase in cutting force thereby maintaining excellent shaving performance. The razor blade has excellent shaving characteristics from the first shave onwards.

Other features and advantages of the invention will be apparent from

the following description of a particular embodiment and from the claims.

FIG. 1 is a vertical sectional view of a cutting edge portion of a razor blade.

FIG. 2 is a perspective view of a shaving razor including the FIG. 1 razor blade.

Referring to FIG. 1, there is shown razor blade 10 including substrate 12, interlayer 14, hard coating layer 16, overcoat layer 18, and outer layer 20. The substrate 12 is typically made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 22 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium containing material. A particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard coating layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides (e.g., boron nitride, niobium nitride or titanium nitride), carbides (e.g., silicon carbide), oxides (e.g., alumina, zirconia) or other ceramic materials. The carbon containing materials can be doped with other elements, such as tungsten, titanium or chromium by including these additives, for example in the target during application by sputtering. The materials can also incorporate hydrogen, e.g., hydrogenated DLC. Preferably coating layer 16 is made of diamond, amorphous diamond or DLC. A particular embodiment includes DLC less than 2,000 angstroms, preferably less than 1,000 angstroms. DLC layers and methods of deposition are described in U.S. Patent No. 5,232,568. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond.

Overcoat layer 18 is used to reduce the tip rounding of the hard



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coated edge and to facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 18 is preferably made of chromium containing material, e.g., chromium or chromium alloys that are compatible with polytetrafluoroethylene, e.g., CrPt. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer.

Outer layer 20 is used to provide reduced friction and includes polytetrafluoroethylene and is sometimes referred to as a telomer. A particular polytetrafluoroethylene material is Krytox LW 1200 available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a niobium interlayer 14, DLC hard coating layer 16, chromium overcoat layer 18, and Krytox LW1200 polytetrafluoroethylene outer coat layer 20. Chromium overcoat layer 18 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200 - 400 angstroms, measured by SEM after application of overcoat layer 18 and before adding outer layer 20.



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Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

In use, razor blade 10 has excellent shaving characteristics from the first shave onwards. Blade 10 has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves provided by the overlayer coating while maintaining excellent shave characteristics.

Other embodiments of the invention are within the scope of the appended claims.



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CLAIMS

1. A razor blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. The blade of claim 1, wherein said hard coating is made of a carbon containing material.

3. The blade of claim 2, wherein said carbon containing material comprises diamond.

4. The blade of claim 2, wherein said hard carbon coating comprises diamond-like carbon material.

5. The blade of claim 2, wherein said hard carbon coating comprises amorphous diamond material.

6. The blade of claim 1, wherein said overcoat layer consists of chromium.

7. The blade of claim 1, wherein said overcoat layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

8. The blade of claim 4, wherein said overcoat layer consists of chromium.

9. The blade of claim 7, wherein said alloy is a chromium platinum alloy.

10. The blade of claim 1, further comprising an interlayer between said substrate and said layer of hard carbon coating.

11. The blade of claim 10, wherein said interlayer comprises niobium.

12. The blade of claim 10, wherein said interlayer comprises a chromium containing material.

13. The blade of claim 6, 7, 8, or 9, wherein said overcoat layer is compressively stressed.



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14. The blade of claim 1, wherein said polytetrafluoroethylene is Krytox LW1200.

15. The blade of claim 4, further comprising a niobium interlayer between said substrate and said hard coating.

16. The blade of claim 8, wherein said polytetrafluoroethylene is Krytox LW1200.

17. The blade of claim 1, wherein said hard coating layer has a thickness less than 2,000 angstroms.

18. The blade of claim 1, wherein said overcoat layer is between 100 and 500 angstroms thick.

19. The blade of claim 1, wherein said outer layer is between 100 and 5,000 angstroms thick.

20. The blade of claim 1, 8, 16 or 17, wherein said blade has a cutting edge that has less rounding with repeated shaves than it would have without said overcoat layer.

21. A shaving razor comprising:

a handle,

a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. The razor of claim 21, wherein said hard coating is made of a carbon containing material.

23. The razor of claim 22, further comprising a niobium interlayer between said substrate and said hard coating.

24. The razor of claim 21 or 22, wherein said overcoat layer consists of



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chromium.

25. A method of making a razor blade comprising:

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

26. The method of claim 25, wherein said adding a layer of hard coating includes vapor depositing a carbon containing material.

27. The method of claim 25, wherein said adding a layer of chromium containing material includes vapor depositing said chromium containing material.

28. The method of claim 27, wherein said adding a layer of chromium containing material includes sputter depositing under conditions to result in compressively stressed material.

29. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -50 volts or an equivalent RF bias scheme.

30. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -200 volts or an equivalent RF bias scheme.

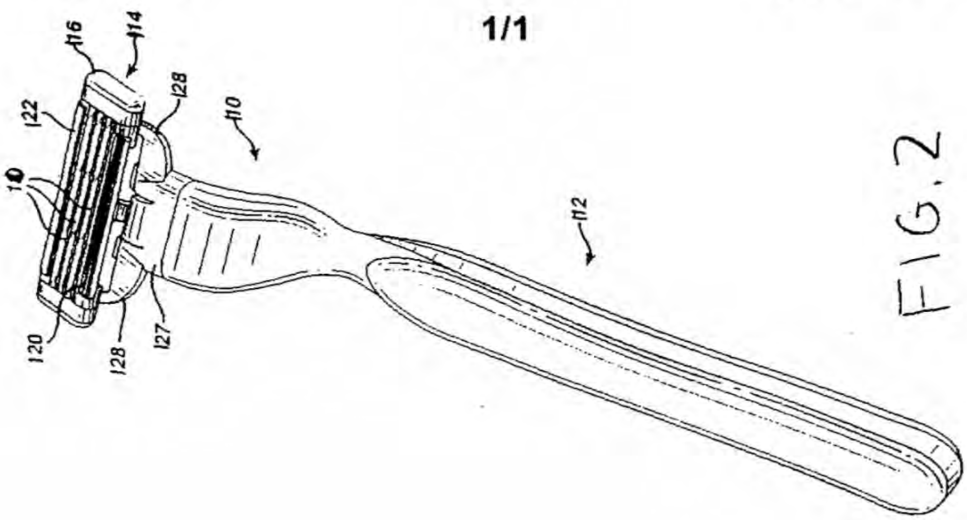


FIG.2

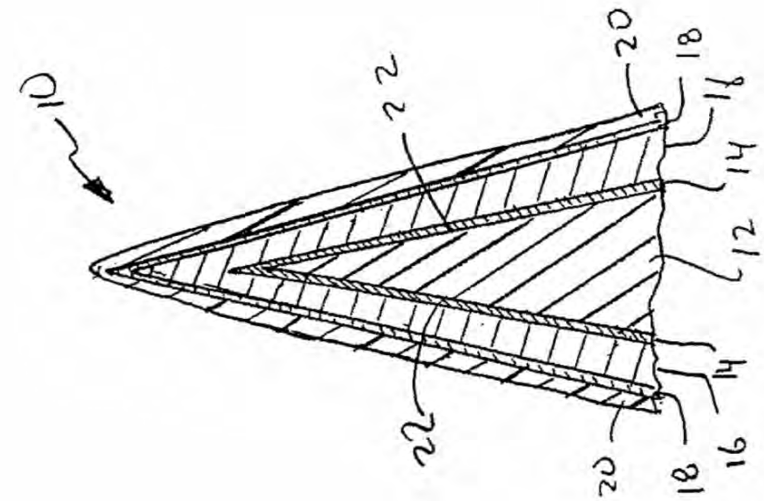


FIG.1



PACE-037251

Document Name: Foreign Language International Publication Drawings (Ex Officio)
Patent: 2001-563289 Date received: Sept. 14, 2002

Document Name: Foreign Language International Publication Drawings (Ex Officio)

Identification of the Case:

| | |
|---|---|
| Application Type: | Patent |
| International Application No.: | PCT/US01/06206 |
| International Filing Date: | Submitted February 27, 2001 |

List of Submitted Material:

| | |
|---|---|
| Material Name: | Figures 1 |

Document Name: Figures

【FIG1】

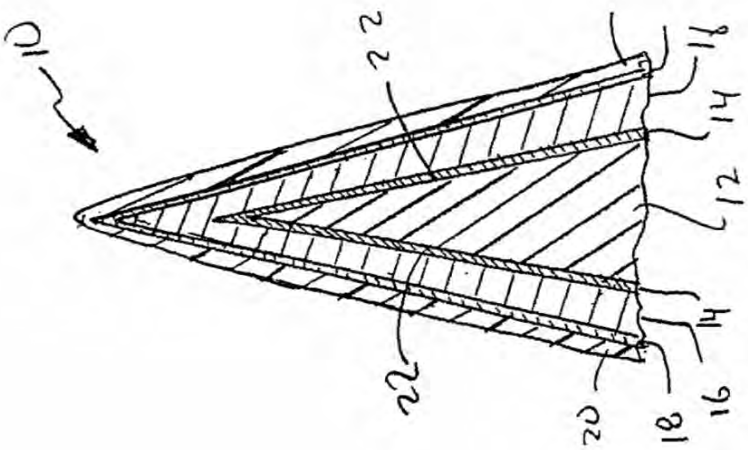


FIG.1

【FIG2】

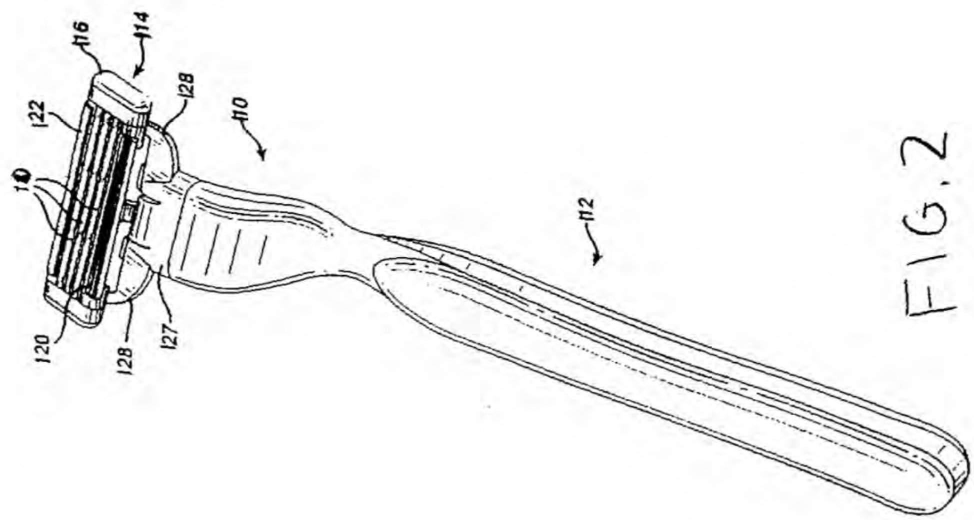


FIG.2



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PCT/US01/06206

(L)60102061361

PATENT COOPERATION TREATY

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Japanese Patent Office
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NOTIFICATION OF ELECTION

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|---|---|
| DATE OF MAILING: 30 OCTOBER 2001 (30.10.01) | |
| INTERNATIONAL APPLICATION NO.: PCT/US01/06206 | APPLICANT'S OR AGENT'S FILE REFERENCE: 8073 |
| INTERNATIONAL FILING DATE: 27 FEBRUARY 2001 (27.02.01) | PRIORITY DATE: 29 FEBRUARY 2000 (29.02.00) |
| APPLICANT: THE GILLETTE COMPANY | |

1. THE DESIGNATED OFFICE IS HEREBY NOTIFIED OF ITS ELECTION MADE:

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FORM PCT/IB/331(JULY 1992)

004111027



PACE-037254

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/64406 A3

(51) International Patent Classification[7]: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

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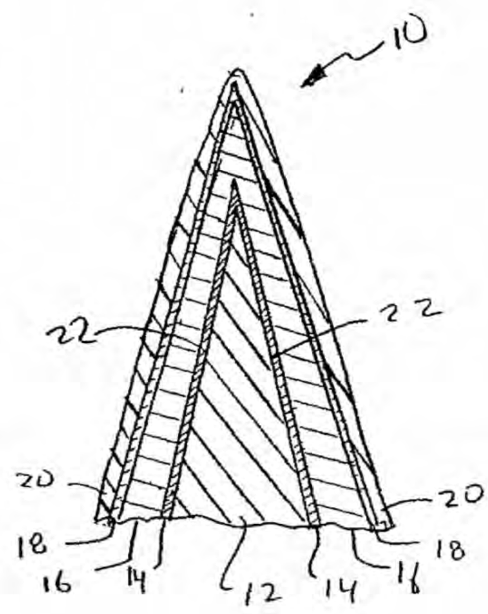
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

*[Continued on next page]*

**(54) Title:** RAZOR BLADE TECHNOLOGY




**(57) Abstract:** A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

WO 01/64406 A3



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**WO 01/64406 A3**

DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

**(84) Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*

**(88) Date of publication of the international search report:**
7 February 2002

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/06206

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26B21/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 3 743 551 A (SANDERSON M) 3 July 1973 (1973-07-03) the whole document | 1,7, 17-19, 21,25 |
| Y | US 5 669 144 A (BROOKS LAMAR EUGENE ET AL) 23 September 1997 (1997-09-23) cited in the application column 3, line 61 -column 4, line 13; claims 15,20 | 1,7, 17-19, 21,25 |
| A | | 10,11, 15,23 |
| A | US 3 838 512 A (SANDERSON M) 1 October 1974 (1974-10-01) column 7, line 4 -column 8, line 11 | 1,7,21, 25 |

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[X] Further documents are listed in the continuation of box C.

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page 1 of 2

# INTERNATIONAL SEARCH REPORT

Interna[...]al Application No
PCT/US 01/06206

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | EP 0 884 142 A (WARNER LAMBERT CO) 16 December 1998 (1998-12-16)<br>claims 1-11<br>----- | 1-5,14, 17,21, 22,25 |

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 01/06206

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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Form PCT/ISA/210 (patent family annex) (July 1992)



PACE-037259

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna al Application No
PCT/US 01/06206

| Patent document cited in search report | | Publication date | Patent family member(s) | | | Publication date |
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Form PCT/ISA/210 (patent family annex) (July 1992)



PACE-037260

(L)60201990328

PATENT COOPERATION TREATY

REC'D 04 JUN 2002
WIPO PCT

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| | | |
|---|---|---|
| Applicant's or agent's file reference<br>8073 | FOR FURTHER ACTION | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
| International application No.<br>PCT/US01/06206 | International filing date (*day/month/year*)<br>27/02/2001 | Priority date (*day/month/year*)<br>29/02/2000 |
| International Patent Classification (IPC) or national classification and IPC<br>B26B21 | | |
| Applicant<br>THE GILLETTE COMPANY et al. | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

| | |
|---|---|
| Date of submission of the demand<br>12/07/2001 | Date of completion of this report<br>04.06.2002 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office - P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk - Pays Bas<br>Tel. +31 70 340 - 2040 Tx: 31 651 epo nl<br>Fax: +31 70 340 - 3016 | Authorized officer<br>Herijgers, J<br>Telephone No. +31 70 340 2226 |

Form PCT/IPEA/409 (cover sheet) (January 1994)



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**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

International application No. PCT/US01/06206

**I. Basis of the report**

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
   **Description, pages:**

   1-5 as originally filed

   **Claims, No.:**

   1-30 as originally filed

   **Drawings, sheets:**

   1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:

Form PCT/IPEA/409 (Boxes I-VIII, Sheet 1) (July 1998)



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**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

International application No. PCT/US01/06206

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   *(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-30 |
| | No: | Claims | |
| Inventive step (IS) | Yes: | Claims | 2-6,8-16,20,22-25,26-30 |
| | No: | Claims | 1,7,17-19,21,25 |
| Industrial applicability (IA) | Yes: | Claims | 1-30 |
| | No: | Claims | |

2. Citations and explanations
   **see separate sheet**

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**INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET** International application No. PCT/US01/06206

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:
   D1: US-A-3743551
   D2: US-A-5669144

2. Document D1, which is considered to represent the most relevant state of the art, discloses (see claim 1) a razor blade comprising a substrate with a cutting edge, a layer of hard coating (lower coating of chromium) on said cutting edge, an overcoat layer of chromium containing material (upper coating of chromium nitride) on said layer of hard coating, and an outer layer of polytetrafluoroethylene coating over said overcoat layer (see claim 8). The subject-matter of claim 1 differs in that the cutting edge is defined by a sharpened tip and adjacent facets. However such cutting edges are generally known, see e.g. D2.
   In view of the previous paragraph, the skilled person would regard it a normal design procedure to combine all the features set out in claim 1. Thus, the subject-matter of claim 1 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

3. The feature of claim 7 is also disclosed by D1, polytetrafluoroethylene being provided on the chromium nitride implies that they are compatible.
   The features of claims 17 to 19 are also disclosed by D1 (see col. 1 lines 53-55). Hence claims 7, and 17 to 19 lack also an inventive step.

4. The same reasoning as set forth in point 2 above leads to the conclusion that claims 21 and 25 also lack an inventive step.

5. The combinations of the features of dependent claims 2, 22 and 26 are neither known from, nor rendered obvious by, the available prior art.The chromium containing overcoat layer over a carbon containing hard layer improves the adhesion of PTFE onto the carbon containing hard layer. Hence these claims and their dependent claims are novel and inventive.

特

特許第４９６４３８３号

| 表示部 | | | | | |
|---|---|---|---|---|---|
| 表示番号（付記） | 登録事項 | | | | |
| １番 | 出願年月日 | 平成１３年　２月２７日 | | 出願番号 | ２００１－５６３２８９ |
| | 査定年月日 | 平成２４年　２月２８日 | | 請求項の数 | ９ |
| | 優先権主張 | 国　　名 | アメリカ合衆国 | | |
| | | 出願年月日 | ２０００年　２月２９日 | 件　　数 | １ |
| | 発明の名称 | カミソリ刃の技術 | | | |
| | | | 登録年月日　平成２４年　４月　６日 | | |

| 特許料記録部 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 特許料 | | | | | | | | | |
| 1年分 | 金額 | 4100円 | 納付日 | 平成24年 3月28日 | 2年分 | 金額 | 4100円 | 納付日 | 平成24年 3月28日 |
| 3年分 | 金額 | 4100円 | 納付日 | 平成24年 3月28日 | 4年分 | 金額 | 11600円 | 納付日 | 平成27年 3月20日 |
| 5年分 | 金額 | 10900円 | 納付日 | 平成28年 4月 1日 | | | | | |

| 甲区 | |
|---|---|
| 順位番号（付記） | 登録事項 |
| １番 | アメリカ合衆国マサチューセッツ州、ボストン、ワン、ジレット、パーク、ワールド、シェイビング、ヘッドクウォーターズ、アイピー／リーガル、パテント、デパートメントー３イー<br>国籍　アメリカ合衆国　　ザ　ジレット　カンパニー<br>登録年月日　平成２４年　４月　６日 |

（以下余白）



上記は特許登録原簿に記録されている事項と相違ないことを認証する。
平成２９年　２月１３日

経済産業事務官　塚原　一浩

PACE-037515

[特許]2001-563289　(13.02.27)

出願 (1) (2001-563289)(13.02.27)　記号 (　　　) 出願種別(01　　　)新法
公開　(　　　)(　　　)　公開基準日 (12.02.29)　国内優先 (0)
公告　(　　　)(24.06.27)　優先 (US 09/515,421　00.02.29) 他 0国
審判 (80)(2012-000717)(24.01.13)　担当 (3C00-3505)( 金本　誠夫　)
登録　( 4964383) (24.04.06)　異議 ( 0) 請求項数 ( 9) 出願料金(　21,000)
公決　(起　)(担　)　文献 (1)　新規性 (0)　菌寄託 (0)　公害 ( )
査定 (1) (起24.02.28)(担3505)　前置 (24.01.23)　解除 (　)公序・要約(0)
(発24.03.02)(官　)　審査・評価請求( 1- )　未請求(1)　自動起案( )
最終　(A01)(24.04.06)　公開準備 ( )　早期審査 ( )
変更先 ( )(　)(　)　審決 ( )(　)　公開後訂正有り
原出願( )(　)(　)種別(　)
期間延長 (23.02.14)　最新起案日 (24.02.28)
公表　(2003-525098) (15.08.26)　翻訳提出 (02.06.13)国際出願(PCT/US01/06206　)
再公表　(　)　国際公開 (W001/64406　01.09.07)　外国語
公開IPC7 B26B 21/60　FN　指定分類IPC　B26B 21/
公告IPC4 B26B 21/60　FIC
名称　カミソリ刃の技術
請求人　代表( ) 種(2)コード(593093249) 国(US)　ザ　ジレット　カンパニー　*
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種(1)コード(100105795) 名塚　聡
種(1)コード(100096895) 岡田　淳平
種(1)コード(100106655) 森　秀行
種(1)コード(100127465) 堀田　幸裕
種(1)コード(100150717) 山下　和也
中間 (A63-2　)国内書面14.06.13( 21,000)完　(A96-7　)認定情報14.11.26(　)
記録 (A62-1　)審査請求19.12.26( 85,000)完　(A52-3　)補正書　19.12.26(　)完
(A96-7　)認定情報20.01.15(　)　(A96-7　)認定情報20.01.15(　)
(A971-007)検索報告22.11.05(　)　(A971-011)利用状況22.11.05(　)
(A13-1　)拒絶理由22.11.12(3505-22)　(A60-1　)期間延長23.02.14(　2,100)完
(A60-2　)延長許可23.02.21(　) A　(A96-7　)認定情報23.02.22(　)
(A53　)意見書　23.03.04(　)完　(A52-3　)補正書　23.03.04(　)完
(A96-7　)認定情報23.03.14(　)　(A96-7　)認定情報23.03.14(　)
(A02　)拒絶査定23.09.13(3505-　)　(A52-3　)補正書　24.01.13(　)完
(C60　)請求書　24.01.13(　)完　(A91-1　)前置移管24.01.23(　)
(C21　)移管通知24.01.24(7088-　)　(A01　)特許査定24.03.02(3505-　)
(A61　)登録納付24.03.28(　)
新出願
国内優先(先)
国内優先(後)
ＩＢ中間記録
(AIB31A )優先権書13.09.07(00008878)完　(AIB349 )国際公開13.09.14(00008878)完
(AIB3492)国際職権13.09.14(00003081)完　(AIB331 )選択通知13.11.26(00002984)完
(AIBC349)国際公開14.02.14(00008878)完　(AIB210 )ＩＳＲ　14.02.14(00008878)完
(AIB338 )ＩＰＥＲ14.10.04(00008878)完

PACE-037516

【審判事件情報】
審判番号 ［2012－000717 ］
審判種別 ［査定不服審判 ］
請求日 ［2012.01.13 ］
審決日 ［ ］
審決 ［前置登録査定 ］
確定日 ［2012.02.28 ］

【書類名】 国内書面

【整理番号】 13722801

【提出日】 平成14年 6月13日

【あて先】 特許庁長官殿

【出願の表示】

【国際出願番号】 PCT/US01/06206

【出願の区分】 特許

【請求項の数】 30

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PACE-037518

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【識別番号】　100117787

【弁理士】

【氏名又は名称】　勝　沼　宏　仁

【手数料の表示】

【予納台帳番号】　087654

【納付金額】　21,000円

【提出物件の目録】

【物件名】　明細書の翻訳文　1

【物件名】　要約書の翻訳文　1

【プルーフの要否】　要

【書類名】　明細書

【発明の名称】　カミソリ刃の技術

【特許請求の範囲】

【請求項１】

尖った先端と近傍面とによって規定された切断刃を有する基材と、

前記切断刃上に設けられたハードコーティング層と、

前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、

前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、

を備えたことを特徴とするカミソリ刃。

【請求項２】

前記ハードコーティングは、物質を含むカーボンから成ることを特徴とする請求項１に記載のカミソリ刃。

【請求項３】

前記物質を含むカーボンは、ダイヤモンドを有することを特徴とする請求項２に記載のカミソリ刃。

【請求項４】

前記ハードカーボンコーティングは、ダイヤモンドライクカーボン物質を含むことを特徴とする請求項２に記載のカミソリ刃。

【請求項５】

前記ハードカーボンコーティングは、アモルファスダイヤモンド物質を含むことを特徴とする請求項２に記載のカミソリ刃。

【請求項６】

前記保護膜層はクロムから成ることを特徴とする請求項１に記載のカミソリ刃。

【請求項７】

前記保護膜層は、ポリテトラフルオロエチレンと相性のよい合金を含むクロムから成ることを特徴とする請求項１に記載のカミソリ刃。

【請求項８】

前記保護膜層はクロムから成ることを特徴とする請求項４に記載のカミソリ刃

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【請求項９】

前記合金は、クロム・プラチナ合金であることを特徴とする請求項７に記載のカミソリ刃。

【請求項１０】

更に、前記基材と前記ハードコーティング層との間に中間層を備えたことを特徴とする請求項１に記載のカミソリ刃。

【請求項１１】

前記中間層は、ニオビウムを有することを特徴とする請求項１０に記載のカミソリ刃。

【請求項１２】

前記中間層は、物質を含むクロムを有することを特徴とする請求項１０に記載のカミソリ刃。

【請求項１３】

前記保護膜層は、圧縮応力を受けていることを特徴とする請求項６，７，８，９のうちいずれか１項に記載のカミソリ刃。

【請求項１４】

前記ポリテトラフルオロエチレンはKrytox LW1200であることを特徴とする請求項１に記載のカミソリ刃。

【請求項１５】

更に、前記基材と前記ハードコーティングとの間にニオビウム中間層を備えたことを特徴とする請求項４に記載のカミソリ刃。

【請求項１６】

前記ポリテトラフルオロエチレンは、Krytox LW1200であることを特徴とする請求項８に記載のカミソリ刃。

【請求項１７】

前記ハードコーティング層は、２，０００オングストロームよりも小さい厚さを有することを特徴とする請求項１に記載のカミソリ刃。

【請求項１８】

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前記保護膜層の厚さは、１００オングストロームと５００オングストロームとの間にあることを特徴とする請求項１に記載のカミソリ刃。

【請求項１９】

前記外層の厚さは、１００オングストロームと５，０００オングストロームとの間にあることを特徴とする請求項１に記載のカミソリ刃。

【請求項２０】

前記カミソリ刃は、前記保護膜層がない場合に比べて、繰り返しヒゲ剃りを行うことによって丸みを帯びることを減少させることができる切断刃を有することを特徴とする請求項１，８、１６、１７のうちいずれか１項に記載のカミソリ刃。

【請求項２１】

ハンドルと、

前記ハンドルに接続されているハウジングと、

前記ハウジングに取り付けられた少なくとも一つのカミソリ刃と、を備えたカミソリであって、

前記カミソリ刃は、

尖った先端と近傍面とによって規定された切断刃を有する基材と、

前記切断刃上に設けられたハードコーティング層と、

前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、

前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、

を有することを特徴とするカミソリ。

【請求項２２】

前記ハードコーティングは、物質を含むカーボンから成ることを特徴とする請求項２１に記載のカミソリ。

【請求項２３】

更に、前記基材と前記ハードコーティングとの間にニオビウム中間層を備えたことを特徴とする請求項２２に記載のカミソリ。

【請求項２４】

前記保護膜層はクロムから成ることを特徴とする請求項２１または２２のいず

れかに記載のカミソリ。

【請求項２５】

尖った先端と近傍面とによって規定された切断刃を有する基材を準備する工程と、

前記切断刃上にハードコーティング層を加える工程と、

前記ハードコーティング層上に、物質を含むクロムの保護膜層を加える工程と、

前記保護膜層上にポリテトラフルオロエチレンコーティングの外層を加える工程と、

を備えたことを特徴とするカミソリ刃の製造方法。

【請求項２６】

前記ハードコーティング層を加える工程は、物質を含むカーボンを蒸着させることを含んでいることを特徴とする請求項２５に記載の方法。

【請求項２７】

前記物質を含むクロムの層を加える工程は、物質を含む前記クロムを蒸着させることを含んでいることを特徴とする請求項２５に記載の方法。

【請求項２８】

前記物質を含むクロムの層を加える工程は、物質に圧縮応力をもたらすような状況下でスパッター付着させることを含んでいることを特徴とする請求項２７に記載の方法。

【請求項２９】

前記スパッターを行うことは、前記対象にDCバイアスを適用して、対象を−50ボルトよりも更に負にし或いは同等のRFバイアス構造とすること、を含むことを特徴とする請求項２８に記載の方法。

【請求項３０】

前記スパッターを行うことは、対象にDCバイアスを適用して、対象を−200ボルトよりも更に負にし或いは同等のRFバイアス構造とすること、を含むことを特徴とする請求項２８に記載の方法。

【発明の詳細な説明】

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【０００１】

本発明は、カミソリ及びカミソリの刃の改良に関する。

【０００２】

カミソリの刃は、一般的には、ステンレス・スティールのような適切な基材物質によって形成されている。そして、切断刃はV字形状で形成され、その最終先端は、略１０００オングストローム未満の半径を有しており、例えば略２００－３００オングストロームの半径を有している。多くの場合、ダイヤモンド、例えば、アモルファスダイヤモンド(amorphous diamond)、ダイヤモンドライクカーボン(diamond-like carbon)(DLC)、窒化物(nitrides)、炭化物(carbides)、酸化物、セラミックといったような硬化コーティングが、強度や耐食性やカミソリ性能を向上させるために使用されており、必要とされる強度を保持するとともに、作用する切断抵抗を減少させるような更に薄いエッジを実現することを可能にしている。ポリテトラフルオロエチレン(PTFE)外層は、摩擦を減少させるために用いられうる。物質を含有するニオビウム(niobium)やクロム(chromium)の中間層は、一般的にはステンレス・スティール製の基材とDLCのような硬化カーボンコーティングとの間における結合を改良するのに役立ちうる。カミソリの刃の刃先の構造や製造工程は、例えば、U.S.特許番号5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; そしてPCT 92/03330において説明されている。そして、このような文献における説明は、参照として本明細書に盛り込まれる。

【０００３】

使用に際して、ハードコーティングおよびポリテトラフルオロエチレン外層を有する最終先端は、繰り返しヒゲを剃ることにより更に丸みを帯びるようになり、先端の丸みが増して、通常、カミソリ性能が減少していると認められるようになる。

【０００４】

発明の特徴のうちある側面は、一般に、尖った先端と近傍面とによって規定された切断刃を有する基材と、切断刃上のハードコーティング層と、ハードコーティング層上の物質を含有するクロム(chromium)の保護膜層と、保護膜層上のポリ

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テトラフルオロエチレンコーティング外層と、を備えたカミソリ刃を特徴としている。

【０００５】

発明の特徴のうち他の側面は、一般に、ハンドルと、尖った先端と近傍面とによって規定された切断刃を具備する基材を有するカミソリヘッドと、切断刃上のハードコーティング層と、ハードコーティング層上の物質を含むクロムの保護膜層と、保護膜層上のポリテトラフルオロエチレンコーティング外層と、を備えたカミソリ刃を特徴としている。

【０００６】

発明の詳細な実施形態は、以下の特徴のうち一つ若しくはそれ以上の特徴を含みうる。詳細な実施形態において、ハードコーティング物質は、物質を含むカーボン（例えば、ダイヤモンドやアモルファスダイアモンドやDLC）や、窒化物(nitrides)や、炭化物(carbides)や、酸化物の他に、セラミックのような物質によって作られることが可能である。ハードコーティング層は、2,000オングストローム未満の厚さとすることが可能である。保護膜層は、クロム、若しくは、クロム・プラチナ合金のようにポリテトラフルオロエチレンと相性のよい合金を含むクロムによって作られることが可能である。保護膜層は、100オングストロームと500オングストロームとの間にある厚さとすることができる。刃は、基材とハードコーティング層との間に中間層を配置しうる。中間層は、物質を含有するニオビウムやクロムを含みうる。ポリテトラフルオロエチレンには、デュポン(DuPont)からのKrytox LW1200を利用することができる。PTFE外層は、１００オングストロームと５０００オングストロームとの間にある厚さとすることができる。

【０００７】

発明の特徴のうち他の側面は、一般に、尖った先端と近傍面とによって規定された切断刃を有する基材を準備して、切断刃上にハードコーティング層を加え、ハードコーティング層上に物質を含むクロムの保護膜層を加え、保護膜層上にポリテトラフルオロエチレンコーティングの外層を加えることで、カミソリ刃を作ることに特徴を有する。

【０００８】

発明の詳細な実施形態は、以下の特徴のうち一つ若しくはそれ以上の特徴を有しうる。詳細な実施形態において、層は、物理的気相成長法（PVD）（すなわちスパッタリング）や化学気相反応法（CVD）によって加えられうる。クロム含有層、より好ましくはクロム、は、圧縮応力が加えられたコーティングをもたらすような状況下で、スパッターにより堆積されうる。スパッターによる物質を含むクロムの堆積は、DCバイアスを対象に適用して、対象を-50ボルトよりも更に負にし、より好ましくは-200ボルトよりも更に負にすることを含みうる。或いは選択的に、適切なRFバイアス構造が、クロム層と同等なものを達成するために使用されうる。

【０００９】

発明の実施形態は、以下の利点のうち一つ若しくはそれ以上の利点を含みうる。保護膜層のクロムの使用は、ハードコーティング層に対するポリテトラフルオロエチレン外層の付着を向上させる。カミソリ刃は、ハードコーティングによってもたらされるエッジ強さを向上させて、ヒゲ剃りの繰り返しに伴い先端が丸みを帯びることを減少させる。先端が丸みを帯びることを減少させることにより、切断抵抗の増加をできる限り抑えて、それにより、卓越したカミソリ性能が保持される。カミソリ刃は、最初のヒゲ剃り前進から、卓越したカミソリ特性を有する。

【００１０】

発明の他の特徴および利点は、以下の詳しい実施の形態の記述および特許請求の範囲の記載によって明らかにされるであろう。

【００１１】

図１は、カミソリ刃における切断刃部分の縦断面図である。図２は、図１のカミソリ刃を具備するカミソリの展望図である。

【００１２】

図１にはカミソリ刃１０が示されており、このカミソリ刃１０は、基材１２と、中間層１４と、ハードコーティング層１６と、保護膜層１８と、外層２０と、を備えている。基材１２は、一般的にはステンレス・スティールによって作られている（但し、他の基材を使用することも可能である）。そして、基材１２は、

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１，０００オングストロームよりも小さい、より好ましくは２００オングストロームから３００オングストロームの範囲の、先端半径となるように尖っている最終先端を有している。更に、基材１２は複数の側面２２を含む外形を有し、この側面２２は、先端から４０ミクロンのところで、１５度から３０度の間の、好ましくは略１９度の角度が測定されている。

【００１３】

中間層１４は、基材に対するハードコーティング層の結合を容易にするために使用されている。適切な中間層物質の例として、ニオビウムと、物質を含むクロムが挙げられる。より詳細には、中間層は、１００オングストロームよりも大きい、より好ましくは５００オングストロームよりも小さい、厚さのニオビウムによって作られている。ニオビウム中間層の使用は、PCT92/03330において説明されている。

【００１４】

ハードコーティング層１６は、強度、耐食性、そしてカミソリ性能の向上をもたらす。そして、ハードコーティング層１６は、物質を含むカーボン（例えば、ダイヤモンド、アモルファスダイアモンド、或いはDLC）、窒化物(nitrides)（例えば、窒化ホウ素(boron nitride)、窒化ニオビウム(niobium nitride)、窒化チタン(titanium nitride)）、炭化物(carbides)（例えば、シリコン炭化物(silicon carbide)、酸化物（例えば、アルミナ(alumina)、ジルコニア(zirconia)）、そして他のセラミック物質、から作られることが可能である。物質を含むカーボンは、例えば、スパッタリングによる適用を行っている間に、タングステン(tungsten)やチタニウム(titanium)やクロミウ(chromium)というこれらの添加物を含ませるように、他の要素とともに対象に対してドープ(doped)されうる。物質は、例えば水素化DLCのように、水素を盛り込むことも可能である。コーティング層１６は、ダイヤモンド、アモルファスダイアモンド、あるいはDLCによって作られていることが好ましい。詳細な実施の形態は、２，０００オングストロームよりも小さい、より好ましくは１，０００オングストロームよりも小さい、DLCを含んでいる。DLC層および付着方法については、U.S.特許番号5232568において説明されている。”物理的気相成長法（PVD）の処理についてのハンドブッ

ク”において説明されているように、DLCはアモルファスカーボン物質である。このアモルファスカーボン物質は、ダイヤモンドの好ましい特性を多く有しているがダイヤモンドの結晶構造は有していない。

【００１５】

保護膜層１８は、ハードコーティングエッジの先端が丸みを帯びることを減少させて、ハードコーティングに対する外層の結合を助長し、依然として両方の利点を保持している。保護膜層１８は物質を含むクロムから作られることが好ましく、例えば、クロムやCrPt.のようにポリテトラフルオロエチレンと相性のよいクロム合金が考えられる。より詳細には、保護膜層は、略100-200オングストロームの厚さを有するクロムである。刃１０は、保護膜層がない場合に比べて、繰り返しのヒゲ剃りにより丸みを帯びることが減少する切断エッジを有している。

【００１６】

外層２０は、摩擦の減少をもたらすために用いられて、ポリテトラフルオロエチレンを含み、時々テロマー（telomer）として言及される。より詳細には、ポリテトラフルオロエチレン物質は、デュポン（DuPont）からのKrytox LW 1200を利用することができる。この物質は、不燃性であって安定した乾燥潤滑油であり、小さな粒子を含んで構成され、これにより安定した分散がもたらされている。２０％の固体成分の水溶性分散は、重さによってもたらされ、浸し塗り(dipping)、吹きつけ、或いはブラッシングによって適用可能となっており、そして、空気乾燥や融解コートされることが可能である。層は、5,000オングストロームよりも小さいことが好ましく、一般的には1,500オングストロームから4,000オングストロームに調整されており、連続的なコーティングを保持するという条件下では、略１００オングストロームの薄さにすることも可能である。連続的なコーティングを実現するという条件下において、テロマーコーティングの厚さを減少させることは、最初のヒゲ剃り結果の改善をもたらしうる。本明細書に参照として盛り込まれたU.S.特許番号5,263,256および5,985,459では、用いられているテロマー層の厚さを減少させるために使用されうる技術が説明されている。

【００１７】

カミソリ刃１０は、通常、上記の参照特許で説明されている過程に従って作ら

れる。より詳細な実施の形態は、ニオビウム中間層１４と、DLCハードコーティング層１６と、クロム保護膜層１８と、Krytox LW1200ポリテトラフルオロエチレンのコーティング外層と、を有している。クロム保護膜層１８は、最小１００オングストローム、最高５００オングストロームで付着される。DCバイアス（-50ボルトよりも更に負で、より好ましくは-200ボルトよりも更に負で）、および、略２ミリトールアルゴン（millitorr argon）の圧力、を使用したスパッタリングによって付着される。先端が丸みを帯びることに対する改良された抵抗を助長するとともに卓越したカミソリ性能を保持すると考えられているクロム保護膜層において、負のバイアスの増加は、（引張応力とは反対の）圧縮応力を促進すると考えられている。刃１０は、保護膜層１８の適用後であって外層２０を加える前に、SEMによって測定された場合、略200-400オングストロームの先端半径を有していることが好ましい。

【００１８】

図２に示すように、刃１０は、カミソリ１１０において用いられることが可能である。このカミソリ１１０は、ハンドル１１２と、交換可能なカミソリカートリッジ１１４と、を有している。カートリッジ１４は、ハウジング１１６を有し、このハウジングは、三つの刃１０と、保護１２０と、キャップ１２２と、を有している。刃１０は、例えば、参照として盛り込まれているU.S.特許番号5,918,369において説明されているように、移動可能に取り付けられている。また、カートリッジ１１４は相互接続部材１２４を有しており、この相互接続部材１２４上では、ハウジング１１６が二つのアーム１２８において枢軸的に取り付けられている。相互接続部材１２４は基部１２７を有しており、この基部１２７は、ハンドル１１２に対して交換可能に接続されている。或いは選択的に、刃１０は、他の種類のカミソリに用いられることが可能であり、一つ、二つ、或いは三つ以上の刃や両側性の刃を有するカミソリ、或いは、移動可能な刃を有していなかったり、カートリッジがカミソリハンドルに対して交換可能に或いは永久的に取り付けられているような旋回ヘッドを有していなかったりするカミソリに用いられることが可能である。

【００１９】

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使用に際して、カミソリ刃１０は、最初のカミソリの進行から、卓越したカミソリ特性を有している。刃１０は、ハードコーティングによって改良されたエッジ強さを有しており、また、保護膜層コーティングによって、繰り返しのヒゲ剃りに伴い先端が丸みを帯びることを減少させるが、卓越したカミソリ特性は保持されている。

【００２０】

発明の他の実施の形態は、特許請求の範囲の有効範囲に含まれる。

【図面の簡単な説明】

【図１】

カミソリ刃における切断刃部分の縦断面図である。

【図２】

図１のカミソリ刃を具備するカミソリの展望図である。

【書類名】　要約書

【要約】

カミソリ刃は、基材を備え、この基材は、尖った先端と近傍面とによって規定された切断刃を有している。また、カミソリ刃は、切断刃上に位置するハードコーティング層と、ハードカーボンコーティング層上に位置し、物質を含むクロムの保護膜層と、保護膜層上に位置するポリテトラフルオロエチレンのコーティング外層と、を備えている。

【選択図】　図1

PACE-037532

# 認定・付加情報

特許出願の番号　　　特願２００１－５６３２８９
受付番号　　　　　　５０２００８６２４７１
書類名　　　　　　　国内書面
担当官　　　　　　　宮本　英明　　　　　３０８１
作成日　　　　　　　平成１４年１１月２５日

＜認定情報・付加情報＞
【特許出願人】
【識別番号】　　　　593093249
【住所又は居所】　　アメリカ合衆国　０２１９９　マサチューセッツ州，ボストン，　プルデンシャル　タワー　ビルディング、（番地なし）
【氏名又は名称】　　ザ　ジレット　カンパニー
【代理人】　　　　　申請人
【識別番号】　　　　100075812
【住所又は居所】　　東京都千代田区丸の内３－２－３　協和特許法律事務所
【氏名又は名称】　　吉武　賢次
【選任した代理人】
【識別番号】　　　　100091982
【住所又は居所】　　東京都千代田区丸の内３丁目２番３号　富士ビル　協和特許法律事務所
【氏名又は名称】　　永井　浩之
【選任した代理人】
【識別番号】　　　　100096895
【住所又は居所】　　東京都千代田区丸の内３丁目２番３号　協和特許法律事務所内
【氏名又は名称】　　岡田　淳平
【選任した代理人】
【識別番号】　　　　100105795
【住所又は居所】　　東京都千代田区丸の内三丁目２番３号　協和特許法律事務所
【氏名又は名称】　　名塚　聡
【選任した代理人】
【識別番号】　　　　100106655

次頁有

# 認定・付加情報（続き）

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【氏名又は名称】　森　秀行
【選任した代理人】
【識別番号】　100117787
【住所又は居所】　東京都千代田区丸の内３丁目２番３号　協和特許法律事務所
【氏名又は名称】　勝沼　宏仁

次頁無

【書類名】　出願審査請求書
【整理番号】　13722860
【提出日】　平成19年12月26日
【あて先】　特許庁長官殿
【出願の表示】
　　【出願番号】　特願2001-563289
【請求項の数】　11
【請求人】
　　【識別番号】　593093249
　　【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】
　　【識別番号】　100075812
　　【弁理士】
　　【氏名又は名称】　吉　武　賢　次
【手数料の表示】
　　【予納台帳番号】　087654
　　【納付金額】　85,000円

# 認定・付加情報

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 受付番号 | ５０７０２６９００８８ |
| 書類名 | 出願審査請求書 |
| 担当官 | 比嘉　八千代　　　　　Ｔ０８８ |
| 作成日 | 平成２０年　１月１１日 |

<認定情報・付加情報>

【請求人】

【識別番号】　593093249

【住所又は居所】　アメリカ合衆国　０２１９９　マサチューセッツ州，ボストン，　プルデンシャル　タワー　ビルディング、（番地なし）

【氏名又は名称】　ザ　ジレット　カンパニー

【代理人】　申請人

【識別番号】　100075812

【住所又は居所】　東京都千代田区丸の内３－２－３　協和特許法律事務所

【氏名又は名称】　吉武　賢次

【書類名】　手続補正書
【整理番号】　13722802
【提出日】　平成19年12月26日
【あて先】　特許庁長官殿
【事件の表示】
　【出願番号】　特願2001-563289
【補正をする者】
　【識別番号】　593093249
　【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】
　【識別番号】　100075812
　【弁理士】
　【氏名又は名称】　吉　武　賢　次
【補正により減少する請求項の数】　19
【手続補正1】
　【補正対象書類名】　明細書
　【補正対象項目名】　特許請求の範囲
　【補正方法】　変更
　【補正の内容】
【特許請求の範囲】
　【請求項１】
カミソリ刃において、
尖った先端と近傍面とによって規定された切断刃を有する基材と、
前記切断刃上に設けられたハードコーティング層と、
前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、
前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、
を備えたことを特徴とするカミソリ刃。
　【請求項２】
前記ハードコーティングは、物質を含むカーボンから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項３】
前記物質を含むカーボンは、ダイヤモンドを有することを特徴とする請求項２に記載のカミソリ刃。
　【請求項４】
前記ハードカーボンコーティングは、ダイヤモンドライクカーボン物質を含むことを特徴とする請求項２に記載のカミソリ刃。
　【請求項５】
前記ハードカーボンコーティングは、アモルファスダイヤモンド物質を含むことを特徴とする請求項２に記載のカミソリ刃。
　【請求項６】
前記保護膜層はクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項７】
前記保護膜層は、ポリテトラフルオロエチレンと相性のよい合金を含むクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項８】
更に、前記基材と前記ハードコーティング層との間に中間層を備えたことを特徴とする請求項１に記載のカミソリ刃。
　【請求項９】
前記中間層は、ニオビウムを有することを特徴とする請求項８に記載のカミソリ刃。
　【請求項１０】

前記中間層は、物質を含むクロムを有することを特徴とする請求項8に記載のカミソリ刃。
【請求項１１】
前記保護膜層は、圧縮応力を受けていることを特徴とする請求項6に記載のカミソリ刃。

# 認定・付加情報

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 受付番号 | ５０７０２６９００９０ |
| 書類名 | 手続補正書 |
| 担当官 | 比嘉　八千代　　Ｔ０８８ |
| 作成日 | 平成２０年　１月１１日 |

＜認定情報・付加情報＞

【補正をする者】

【識別番号】　593093249

【住所又は居所】　アメリカ合衆国　０２１９９　マサチューセッツ州，ボストン，　プルデンシャル　タワー　ビルディング、（番地なし）

【氏名又は名称】　ザ　ジレット　カンパニー

【代理人】　申請人

【識別番号】　100075812

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【氏名又は名称】　吉武　賢次

PACE-037539

# 検索報告書

書誌事項

| | |
|---|---|
| 登録調査機関名 | 一般財団法人工業所有権協力センター |
| 登録調査機関コード | 001 |

| | | | |
|---|---|---|---|
| 指導者名 | — | 指導者コード | L096 |
| 検索者名 | — | 検索者コード | KY49 |
| レコード種別 | 161 | | |
| テーマコード | 3C066 | | |
| 特許出願の番号 | 特願2001-563289 | | |
| 外注管理番号 | 2010119756 | | |
| 納品種別 | 3 | 1：納品型　2：対話型（内国）　3：対話型（外国） | |
| 対話実施日 | 2010年11月 4日 | | |
| 初期評価指定 | 2 | 1：通常　2：初期評価 | |
| 検索日 | 2010年10月 5日 | | |
| 検索報告書作成日 | 2010年10月 5日 | | |
| まとめ種別 | 無し | | |

1．本願発明の特徴

【本願発明の特徴を表す図面番号】：　　　　図
<<本願発明の特徴>>
【請求項１】
(a)　カミソリ刃において、
尖った先端と近傍面とによって規定された切断刃を有する基材と、
前記切断刃上に設けられたハードコーティング層と、
(b)　前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、

前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、
を備えたことを特徴とするカミソリ刃。
【請求項２】
(c)　前記ハードコーティングは、物質を含むカーボンから成ることを特徴とする請求項１に記載のカミソリ刃。
【請求項３】
(d)　前記物質を含むカーボンは、ダイヤモンドを有することを特徴とする請求項２に記載のカミソリ刃。

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【請求項４】
(e)　前記ハードカーボンコーティングは、ダイヤモンドライクカーボン物質を含むことを特徴とする請求項２に記載のカミソリ刃。
【請求項５】
(f)　前記ハードカーボンコーティングは、アモルファスダイヤモンド物質を含むことを特徴とする請求項２に記載のカミソリ刃。
【請求項６】
(g)　前記保護膜層はクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
【請求項７】
(h)　前記保護膜層は、ポリテトラフルオロエチレンと相性のよい合金を含むクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
【請求項８】
(i)　更に、前記基材と前記ハードコーティング層との間に中間層を備えたことを特徴とする請求項１に記載のカミソリ刃。
【請求項９】
(j)　前記中間層は、ニオビウムを有することを特徴とする請求項８に記載のカミソリ刃。
【請求項１０】
(k)　前記中間層は、物質を含むクロムを有することを特徴とする請求項８に記載のカミソリ刃。
【請求項１１】
(l)　前記保護膜層は、圧縮応力を受けていることを特徴とする請求項６に記載のカミソリ刃。

２．検索論理式

年月範囲：　　年　月　日～2000年 2月29日

| 【No.】 | 【クレームNo.】 | 【テーマコード】 | 【検索論理式】 | 【件数】 |
|---|---|---|---|---|
| 1 | 1~11 | 3C066 | [B26B21/60]*[コーティング+保護膜](FW+全文)-Σ¥ | 20 |
| 2 | 1~11 | 3C066 | [B26B21/60]*[ポリテトラフルオロエチレン+ＰＴＦＥ+外層](FW+全文)-Σ¥ | 11 |
| 3 | 1~11 | 3C066 | [B26B21/60]-Σ¥ | 91 |
| 4 | 1~11 | 3C066 | (コーティング+保護膜)/TX-Σ¥ | 32 |
| 5 | 1~11 | 3C066 | (ポリテトラフルオロエチレン+ＰＴＦＥ+外層)/TX-Σ¥ | 4 |

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スクリーニング件数合計： 158

3．スクリーニングサーチの結果（提示文献毎の表示）

| 【No．】 | 【提示文献の種類】 | 【対話型追加文献の種別】 | 【提示文献】 | 【代表カテゴリ】 | 【式No．】 |
|---|---|---|---|---|---|
| 1 | 特許文献 | | 特表平０６－５０７１００号公報 | A | 1 |
| 2 | 特許文献 | | 特表平０７－５０３３７７号公報 | A | 1 |
| 3 | 特許文献 | | 特表平１１－５１２６３４号公報 | A | 2 |
| 4 | 特許文献 | | 特開平０２－０６５８９１号公報 | A | 2 |
| 5 | 特許文献 | | 特開平１１－００９８５７号公報 | A | 1 |
| 6 | 特許文献 | | 米国特許第０３７４３５５１号明細書 | A | 備考 |
| 7 | 特許文献 | | 米国特許第０５６６９１４４号明細書 | A | 備考 |

【提示文献数】： 7

4．スクリーニングサーチの結果（クレーム別形式）

| 【クレームNo．】 | 【文献No．】 | 【カテゴリー】 | 【関連個所】 | 【本願発明との対比相違点及び発見できなかった構成について】 |
| --- | --- | --- | --- | --- |
| 1 | 1 | A | a［P4,F3b'［P5,F3 | 切断刃を有する本体部分（基材）と、DLCの外層（ハードコーティング層）と、PTFEのコーティング（外層）とを備えたかみそり刃の従来例<br><br>--->ハードコーティング層上のクロムを含む保護膜層がない |
|  | 2 | A | a［P4,F3b'［P5,F3 | 切断刃を有する本体（基材）と、DLCの外層（ハードコーティング層）と、PTFEのコーティング（外層）とを備えたかみそり刃の従来例<br><br>--->ハードコーティング層上のクロムを含む保護膜層がない |
|  | 3 | A | a［P9,F5b'［P9,F5 | 切断刃を有する基材と、DLNの外層（ハードコーティング層）と、PTFEのコーティング（外層）とを備えたかみそり刃の従来例<br><br>--->ハードコーティング層上のクロムを含む保護膜層がない |
|  | 4 | A | a［P3,F1b'［P3,F1 | ステンレス鋼の基板（基材）と、クロムまたは窒化クロムの硬質皮膜（ハードコーティング層）と、PTFEのコーティング（外層）とを備えたかみそり刃の従来例<br><br>--->保護膜とは記されていないが、クロムまたは窒化クロムの硬質皮膜は、保護膜を兼ねると想定できればY2文献 |
|  | 5 | A | b'［N3 | 切断縁上にクロムの薄い層のベースを有したPTFEにより、刃の腐食抵抗を増大したカミソリ刃の従来例 |

| | | | | |
|---|---|---|---|---|
| | | | | --->ハードコーティング層上でない |
| | 6 | A | a ［N1b'［N1 | razor blade（切断刃）と、chromium nitride（ハードコーティング層）と、PTFEのコーティングとを備えたかみそり刃の従来例<br><br>--->ハードコーティング層上のクロムを含む保護膜層がない |
| | 7 | A | a ［N1b'［N1 | stainless steer body（切断刃）と、DLC（ハードコーティング層）と、adherent telomer layer（PTFEのコーティング）とを備えたかみそり刃の従来例<br><br>--->ハードコーティング層上のクロムを含む保護膜層がない |
| 2,3,4 | 1 | A | ［P4 | ダイヤモンド状の炭素（DLC）の従来例 |
| | 2 | A | ［P4 | ダイヤモンド状の炭素（DLC）の従来例 |
| | 5 | A | ［N11 | ダイヤモンド状の炭素（DLC）の従来例 |
| 5 | 5 | A | ［N15 | アモルファスダイヤモンドの従来例 |
| 6 | 4 | A | g ［P3,F1 | クロムまたは窒化クロムの硬質皮膜（保護膜層）の従来例 |
| 7 | 4 | A | h ［P3,F1 | クロムまたは窒化クロムの硬質皮膜（保護膜層）の従来例 |
| 8 | 1 | A | i ［P4,F3 | 基材とハードコーティング層の間に中間層を備えたもの従来例 |
| | 3 | A | i ［P9,F6 | 基材とハードコーティング層の間に中間層を備えた従来例 |
| 9 | 1 | A | j ［P4,F3 | ニオビュームの中間層である従来例 |
| 10 | 2 | A | k'［P4 | モリブデン中間層の従来例<br><br>--->クロムを含む中間層でない |
| 11 | 3 | A | ［P12 | 高い内部応力を有したDLCフィルムの従来例<br><br>--->保護膜層の圧縮応力についての記載はない |

５．備考（検索者用）

サーチ文献６、７は、国際サーチのY文献です

# 検索外注利用状況票

平成２２年１１月　５日

登録調査機関名　一般財団法人工業所有権協力センター
調査機関コード　００１
テーマコード　３Ｃ０６６
管理番号　２０１０１１９７５６
出願番号　特願２００１－５６３２８９
審査官　金本　誠夫　３５０５　３Ｃ００

納品後の第一回起案　拒絶理由通知書第２９条第２項

報告書不採用の有無　無
評価　－

提示文献

| ＮＯ | 利用 | 対話追加 | 提示文献名 |
|---|---|---|---|
| １ | ○ | － | 特表平０６－５０７１００号公報 |
| ２ | － | － | 特表平０７－５０３３７７号公報 |
| ３ | － | － | 特表平１１－５１２６３４号公報 |
| ４ | － | － | 特開平０２－０６５８９１号公報 |
| ５ | ○ | － | 特開平１１－００９８５７号公報 |
| ６ | － | － | 米国特許第０３７４３５５１号明細書 |
| ７ | － | － | 米国特許第０５６６９１４４号明細書 |

追加サーチの有無　無

追加サーチの検索式

追加引用文献

| ＮＯ | テーマ内 | テーマ | 追加引用文献名 |
|---|---|---|---|

追加引用文献数　０
自テーマ引用文献数　０
他テーマ引用文献数　０

対話型検索実施の有無　有

対話型検索の実施日　平成２２年１１月　４日

備考

# 拒絶理由通知書

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 起案日 | 平成２２年１１月　５日 |
| 特許庁審査官 | 金本　誠夫　　３５０５　３Ｃ００ |
| 特許出願人代理人 | 吉武　賢次（外　５名）　様 |
| 適用条文 | 第２９条第２項 |

この出願は、次の理由によって拒絶をすべきものです。これについて意見がありましたら、この通知書の発送の日から３か月以内に意見書を提出してください。

理　由

この出願の下記の請求項に係る発明は、その出願前に日本国内又は外国において、頒布された下記の刊行物に記載された発明又は電気通信回線を通じて公衆に利用可能となった発明に基いて、その出願前にその発明の属する技術の分野における通常の知識を有する者が容易に発明をすることができたものであるから、特許法第２９条第２項の規定により特許を受けることができない。

記　（引用文献等については引用文献等一覧参照）

・請求項　１－１０
・引用文献等　１，２
・備考
（請求項１，６について）
引用文献１の従来技術に記載された発明には、ＰＴＦＥの外層を備える際に保護膜層（クロムの薄い層が相当する。）を設けるカミソリ刃が開示されている（第【０００３】段落等参照）。
また、引用文献１，２の実施例に記載された発明には、尖った先端と近傍面とによって規定された切断刃を有する基材と、前記切断刃上に設けられたハードコーティング層と、前記ハードコーティング層上をコーティングするポリテトラフルオロエチレンの外層と、を備えたカミソリ刃が開示されている（引用文献１の第【００１５】段落、引用文献２の第４頁右上欄下から４行目～同左下欄第６行目、第５頁右上欄第１１～１２行目及び第３図、等参照）。
してみると、引用文献１の従来技術に記載された発明を引用文献１，２の実施例に記載された発明のカミソリ刃に適用することは当業者が容易に想到し得たこ

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とである。

（請求項２－４について）
引用文献１，２に記載された発明のハードコーティング層は、ＤＬＣである。

（請求項５について）
引用文献１に記載された発明のハードコーティング層は、アモルファスダイヤモンド物質を含む層である。

（請求項７について）
引用文献１の従来技術に記載された発明を引用文献１，２の実施例に記載された発明のカミソリ刃に適用する際、保護膜層としてＰＴＦＥと相性のよい合金を含ませることは当業者が容易に想到し得たことである。

（請求項８，９について）
引用文献２に記載された発明のカミソリ刃は、基材とハードコーティング層との間にニオビウムを有する中間層を備えている。

（請求項１０について）
引用文献１，２に記載された発明のカミソリ刃は、クロム族であるモリブデンからなる中間層を有する。
してみると、引用文献１，２の実施例に記載された発明の中間層が、物質を含むクロムを有するようにすることは当業者が容易に想到し得たことである。

したがって、本願の請求項１－１０に係る発明は、引用文献１，２に記載された発明に基いて当業者が容易に発明をすることができたものである。

引　用　文　献　等　一　覧

1. 特開平１１－００９８５７号公報
2. 特表平０６－５０７１００号公報

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＜留意事項＞
（１）明細書を補正した場合は、補正により記載を変更した箇所に下線を引くこと（特許法施行規則様式第１３備考６）。
（２）補正は、この出願の出願当初の明細書又は図面に記載した事項の範囲内で

行わなければならない。補正の際には、意見書で、各補正事項について補正が適法なものである理由を、根拠となる出願当初の明細書等の記載箇所を明確に示したうえで主張されたい。

（３）この拒絶理由通知書中で指摘した請求項以外の請求項１１に係る発明については、現時点では、拒絶の理由を発見しない。拒絶の理由が新たに発見された場合には拒絶の理由が通知される。

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先行技術文献調査結果の記録

・調査した分野　　ＩＰＣ　B26B21/00-21/60

この先行技術文献調査結果の記録は、拒絶理由を構成するものではありません。

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この拒絶理由通知の内容に関するお問い合わせがございましたら下記までご連絡下さい。

特許審査第二部　生産機械　金本誠夫
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| 部長／代理 | 審査長／代理 | 審査官 | 審査官補 |
| --- | --- | --- | --- |
| | 八木　誠 | 金本　誠夫 | |
| | ９３４８ | ３５０５ | |

PACE-037551

【書類名】　期間延長請求書
【整理番号】　13722888
【提出日】　平成23年 2月14日
【あて先】　特許庁審査官　殿
【事件の表示】
　【出願番号】　特願2001-563289
【請求人】
　【識別番号】　593093249
　【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】
　【識別番号】　100075812
　【弁理士】
　【氏名又は名称】　吉　武　賢　次
【発送番号】　808295
【請求の内容】　上記事件について、手続書類の翻訳のため、提出期間を１ヶ月延長されたく請求いたします。
【手数料の表示】
　【予納台帳番号】　087654
　【納付金額】　2,100円

# 認定・付加情報

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 受付番号 | ５１１００３０３０３９ |
| 書類名 | 期間延長請求書 |
| 担当官 | 指定官庁３上席　　　００３３ |
| 作成日 | 平成２３年　２月２１日 |

＜認定情報・付加情報＞

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【氏名又は名称】　ザ　ジレット　カンパニー

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【氏名又は名称】　吉武　賢次

【書類名】　意見書
【整理番号】　13722870
【提出日】　平成23年 3月 4日
【あて先】　特許庁審査官　殿
【事件の表示】
　【出願番号】　特願2001-563289
【特許出願人】
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【発送番号】　808295
【意見の内容】
（１）拒絶理由の内容
　本願は、請求項１－１０に係る発明が、下記の引用文献１－２に記載された発明に基づいて容易に発明することができたものであるから、特許法第２９条第２項の規定により特許を受けることができない、旨認定された。
　　引用文献１：特開平１１－００９８５７号公報
　　引用文献２：特表平０６－５０７１００号
　これに対して本件出願人は明細書の特許請求の範囲を補正するとともに、以下意見を述べる。
　なお、特許請求の範囲の補正事項は、出願当初の明細書の記載および図面の記載（とりわけ、補正前の請求項２、明細書の段落［０００６］、［００１４］）に基づいている。

（２）本件出願人の意見
　（ｉ）本願発明の特徴
　本願発明の要旨は、別紙手続補正書により補正した特許請求の範囲の請求項１に記載の通りであるが、とりわけ主要な構成として以下の点を特徴としている。
　（ａ）カーボンから成るハードコーティング層上に、物質を含むクロムの保護膜層が設けられていること。
　（ｂ）保護膜層上に、ポリテトラフルオロエチレンの外層がコーティングされていること。
　しかして本願発明によれば、上記特徴（ａ）、（ｂ）の組み合わせにより、カーボンから成るハードコーティング層と、ポリテトラフルオロエチレンの外層との間に、クロムの保護膜層が介在される。このことにより、ハードコーティング層に対するポリテトラフルオロエチレンの外層の付着を向上させることができる。また、カミソリ刃は、ハードコーティング層によってもたらされるエッジ強さを向上させて、ひげそりの繰り返しに伴い先端が丸みを帯びることを減少させ、切断抵抗の増加をできる限り抑え、卓越したカミソリ性能を保持することができる。すなわち、カミソリ刃は、最初のひげそり時から卓越したカミソリ特性を保持し続けることができる（本願明細書の段落［０００８］および［００１５］参照）。

　（ii）引用文献との対比
　　（引用文献１）
　一方、引用文献１に記載されたものは、「カミソリ刃及びその製造方法」であるが、引用文献１には上述した本願発明の特徴（ａ）、（ｂ）について何も記載されていない。
　すなわち、引用文献１には、「適当な厚さの内側コーティングを刃の縁部に堆積することによって行われる。このコーティングは、酸化物、炭化物、ホウ化物、金属およびその

組み合わせを含む互換性金属からなるが、好ましい金属は、セラミック、クロム、クロム／プラチナ及び窒化クロムを含む。」という記載がある（引用文献１の明細書の段落［００１４］参照）。

また、引用文献１には、「縁部は、非常に低い摩擦係数を有する非ポリマー材料の薄いフィルムの外側コーティングでコートされる。（・・・）。薄いフィルムコーティングのこのような低い摩擦係数の好ましい値は、アモルファスダイヤモンド、ダイヤモンド状炭素（ＤＬＣ）、モリブデンジサルファイドまたは他の同様な材料である。」という記載がある（同段落［００１５］参照）。

さらに、引用文献１には、「特に好ましい実施例において、まず刃の縁部はアモルファスダイヤモンドのような低摩擦係数を有する薄いフィルムでコートされ、最小限の切断力をシェービングに提供するために低分子重量PTFEまたはKRYTOX１０００のような潤滑性ポリマーでコートされる。」という記載がある（同段落［００１５］参照）。

このように、引用文献１では、切断刃上に、クロムを含む内側コーティングと、ダイヤモンド状炭素（ＤＬＣ）を含む外側コーティングと、ＰＴＦＥの潤滑性ポリマーコートがこの順に設けられるようになっている。

しかしながら、引用文献１には、ダイヤモンド状炭素（ＤＬＣ）を含むコーティングと、ＰＴＦＥの潤滑性ポリマーコートとの間に、クロムを含むコーティングが介在される旨の記載はなく、そのようなことを示唆する旨の記載もない。ましてや、このような引用文献１からは、ダイヤモンド状炭素（ＤＬＣ）を含むコーティングと、ＰＴＦＥの潤滑性ポリマーコートとの間に、クロムを含むコーティングが介在させて、ダイヤモンド状炭素（ＤＬＣ）を含むコーティングと、ＰＴＦＥの潤滑性ポリマーコートとの付着を向上させ、カミソリ特性を保持するという本願発明の思想を読取ることは到底できない。

これに対して、本願発明によれば、カーボンから成るハードコーティング層上に、物質を含むクロムの保護膜層が設けられ（上述した本願発明の特徴（ａ））、保護膜層上に、ポリテトラフルオロエチレンの外層がコーティングされている（上述した本願発明の特徴（ｂ））ことを特徴としており、この点で両者の構成は全く相違する。

（引用文献２）

また、引用文献２に記載されたものは、「かみそり刃に関する改良」であるが、引用文献２には上述した本願発明の特徴（ａ）、（ｂ）について何も記載されていない。

すなわち、引用文献２においては、「ニオビウムの中間層５８上にダイヤモンド状の炭素（ＤＬＣ）の外層６０があり、（・・・）。層６０上には、積層厚さとして実質的な厚さを有しているが最初のひげそり中に単一層の厚さに減少される接着テロマー層７２が配置されている。」という記載がある（引用文献２の明細書第４頁左下欄第４行目乃至同第１５行目参照）。

また、引用文献２には、「次に、ポリテトラフルオロエチレンのコーティング７２が」という記載がある（同第５頁右上欄第１１行目乃至同第１２行目参照）。

このように、引用文献２では、本体部分５０上に、ニオビウムの中間層５８と、ダイヤモンド状の炭素（ＤＬＣ）の外層６０と、ポリテトラフルオロエチレンのコーティング７２が、この順に設けられるようになっている。

しかしながら、引用文献２には、ダイヤモンド状の炭素（ＤＬＣ）の外層６０と、ポリテトラフルオロエチレンのコーティング７２との間に、クロムの保護膜層が介在されている旨の記載はなく、そのようなことを示唆する旨の記載もない。ましてや、このような引用文献２からは、ダイヤモンド状の炭素（ＤＬＣ）の外層６０と、ポリテトラフルオロエチレンのコーティング７２との間に、クロムの保護膜層を介在させて、ダイヤモンド状の炭素（ＤＬＣ）の外層６０と、ポリテトラフルオロエチレンのコーティング７２との付着を向上させて、かみそり特性を保持するという本願発明の思想を読取ることは到底できない。

これに対して、本願発明によれば、カーボンから成るハードコーティング層上に、物質を含むクロムの保護膜層が設けられ（上述した本願発明の特徴（ａ））、保護膜層上に、ポリテトラフルオロエチレンの外層がコーティングされている（上述した本願発明の特徴

（ｂ））ことを特徴としており、この点で両者の構成は全く相違する。

（３）結び

以上のように、本願発明は、上記各引用文献１－２に記載された発明と構成及び作用効果が相違するとともに、上記各引用文献１－２を組合せたとしてもその構成及び作用効果が相違するので、上記各引用文献１－２に記載された発明に基づいて容易に発明することができたものではない、と考える。

なお、本願に対応する欧州特許出願が、上記引用文献１に対応する文献（ＥＰ０，８８４，１４２）を引用されながらも、特許査定されていることを申し添えておきます（ＥＰ１，２５９，３６１）。

上記点をご考慮の上、特許すべき旨の査定をお願いいたします。

# 認定・付加情報

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|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 受付番号 | ５１１００４５６０２６ |
| 書類名 | 意見書 |
| 担当官 | 指定官庁３上席　　　０００３３ |
| 作成日 | 平成２３年　３月１１日 |

＜認定情報・付加情報＞

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【書類名】　手続補正書
【整理番号】　13722803
【提出日】　平成23年 3月 4日
【あて先】　特許庁長官殿
【事件の表示】
　【出願番号】　特願2001-563289
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　【氏名又は名称】　吉　武　賢　次
【発送番号】　808295
【補正により減少する請求項の数】　1
【手続補正1】
　【補正対象書類名】　明細書
　【補正対象項目名】　特許請求の範囲
　【補正方法】　変更
　【補正の内容】
【特許請求の範囲】
　【請求項１】
カミソリ刃において、
尖った先端と近傍面とによって規定された切断刃を有する基材と、
前記切断刃上に設けられたハードコーティング層と、
前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、
前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、
を備え、
前記ハードコーティングは、物質を含むカーボンから成ることを特徴とするカミソリ刃。
　【請求項２】
前記物質を含むカーボンは、ダイヤモンドを有することを特徴とする請求項1に記載のカミソリ刃。
　【請求項３】
前記ハードカーボンコーティングは、ダイヤモンドライクカーボン物質を含むことを特徴とする請求項1に記載のカミソリ刃。
　【請求項４】
前記ハードカーボンコーティングは、アモルファスダイヤモンド物質を含むことを特徴とする請求項1に記載のカミソリ刃。
　【請求項５】
前記保護膜層はクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項６】
前記保護膜層は、ポリテトラフルオロエチレンと相性のよい合金を含むクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項７】
更に、前記基材と前記ハードコーティング層との間に中間層を備えたことを特徴とする請求項１に記載のカミソリ刃。
　【請求項８】
前記中間層は、ニオビウムを有することを特徴とする請求項7に記載のカミソリ刃。
　【請求項９】

前記中間層は、物質を含むクロムを有することを特徴とする請求項7に記載のカミソリ刃。

【請求項１０】
前記保護膜層は、圧縮応力を受けていることを特徴とする請求項5に記載のカミソリ刃。

# 認定・付加情報

特許出願の番号　　　特願２００１－５６３２８９
受付番号　　　　　　５１１００４５６０２８
書類名　　　　　　　手続補正書
担当官　　　　　　　指定官庁３上席　　　　０３３
作成日　　　　　　　平成２３年　３月１１日

＜認定情報・付加情報＞
【補正をする者】
【識別番号】　　　593093249
【住所又は居所】　アメリカ合衆国マサチューセッツ州、ボストン、ワン、ジレット、パーク、ワールド、シェイビング、ヘッドクウォーターズ、アイピー／リーガル、パテント、デパートメント－３イー
【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】　　　　申請人
【識別番号】　　　100075812
【住所又は居所】　東京都千代田区丸の内３－２－３　協和特許法律事務所
【氏名又は名称】　吉武　賢次

# 拒絶査定

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 起案日 | 平成２３年　９月　８日 |
| 特許庁審査官 | 金本　誠夫　　　３５０５　３Ｃ００ |
| 発明の名称 | カミソリ刃の技術 |
| 特許出願人 | ザ　ジレット　カンパニー |
| 代理人 | 吉武　賢次（外　５名） |

この出願については、平成２２年１１月　５日付け拒絶理由通知書に記載した理由によって、拒絶をすべきものです。

なお、意見書及び手続補正書の内容を検討しましたが、拒絶理由を覆すに足りる根拠が見いだせません。

備考

（請求項１－１０について）

出願人は平成２３年３月４日付け手続補正書において、旧請求項１を削除し、旧請求項２を新請求項１とする補正を行った。

そして、同日付け意見書において、引用文献１，２に記載された発明にはいずれにも、ＤＬＣ層とＰＴＦＥ層との間に、クロムの保護膜層が介在されている旨の記載はなく、そのようなことを示唆する旨の記載もない、と主張している。

しかしながら、請求項１については、引用文献１には「大部分のカミソリ刃は、刃の腐食抵抗を増大し、ポリテトラフルオロエチレン（ＰＴＦＥ）のような潤滑性ポリマーの適用に適正なベースを提供するように切断縁上にクロムの薄い層を有する。」（第【０００３】段落）と記載されている。この記載は、ＰＴＦＥ層のベース層としてクロムの薄い層が適正であるということが開示されていると認められる（発明Ａ）。

そして、引用文献１，２に記載された発明には、出願人が意見書でも述べているとおり、ＤＬＣ層にＰＴＦＥ層を設けた点が開示されている（発明Ｂ）。

してみると、発明Ｂに発明Ａを適用して、ＤＬＣ層とＰＴＦＥ層との間にクロムの薄い層を介在することは当業者が容易に想到し得たことである。

その他の請求項については、上記拒絶理由通知書を参照されたい。

したがって、出願人の主張は採用できない。

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この査定に不服があるときは、この査定の謄本の送達があった日から３月以内（在外者にあっては、４月以内）に、特許庁長官に対して、審判を請求することができます（特許法第１２１条第１項）。
（行政事件訴訟法第４６条第２項に基づく教示）
この査定に対しては取消訴訟を提起することはできません。この査定についての審判請求に対する審決に対してのみ取消訴訟を提起することができます（特許法第１７８条第６項）。

＜審判請求時に補正をする際の注意＞
（１）明細書について補正をする場合は、補正により記載を変更した個所に下線を引くこと（特許法施行規則様式第１３備考６）。
（２）補正は、この出願の出願当初の明細書又は図面に記載した事項の範囲内で行わなければならない。さらに、特許請求の範囲について補正をする際には、請求項の削除、特許請求の範囲の限定的減縮、誤記の訂正又は明瞭でない記載の釈明（拒絶の理由に示す事項についてするものに限る）を目的とする補正に限られる。また、審判請求書の請求の理由において、各補正事項について補正が適法なものである理由を、根拠となる出願当初の明細書等の記載箇所を明確に示したうえで主張されたい。

| 部長／代理 | 審査長／代理 | 審査官 | 審査官補 |
| --- | --- | --- | --- |
| | 田中　成彦 | 金本　誠夫 | |
| | ３１１０ | ３５０５ | |

【書類名】　手続補正書
【整理番号】　13722804
【提出日】　平成24年 1月13日
【あて先】　特許庁長官殿
【事件の表示】
　【審判請求日】　平成24年 1月13日
　【出願番号】　特願2001-563289
【補正をする者】
　【識別番号】　593093249
　【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】
　【識別番号】　100117787
　【弁理士】
　【氏名又は名称】　勝　沼　宏　仁
【補正により減少する請求項の数】　1
【手続補正1】
　【補正対象書類名】　明細書
　【補正対象項目名】　特許請求の範囲
　【補正方法】　変更
　【補正の内容】
【特許請求の範囲】
　【請求項１】
カミソリ刃において、
尖った先端と近傍面とによって規定された切断刃を有する基材と、
前記切断刃上に設けられたハードコーティング層と、
前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、
前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、
を備え、
前記ハードコーティングは、物質を含むカーボンから成り、
前記保護膜層は、圧縮応力を受けていることを特徴とするカミソリ刃。
　【請求項２】
前記物質を含むカーボンは、ダイヤモンドを有することを特徴とする請求項１に記載のカミソリ刃。
　【請求項３】
前記ハードカーボンコーティングは、ダイヤモンドライクカーボン物質を含むことを特徴とする請求項１に記載のカミソリ刃。
　【請求項４】
前記ハードカーボンコーティングは、アモルファスダイヤモンド物質を含むことを特徴とする請求項１に記載のカミソリ刃。
　【請求項５】
前記保護膜層はクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項６】
前記保護膜層は、ポリテトラフルオロエチレンと相性のよい合金を含むクロムから成ることを特徴とする請求項１に記載のカミソリ刃。
　【請求項７】
更に、前記基材と前記ハードコーティング層との間に中間層を備えたことを特徴とする請求項１に記載のカミソリ刃。
　【請求項８】
前記中間層は、ニオビウムを有することを特徴とする請求項７に記載のカミソリ刃。
　【請求項９】

前記中間層は、物質を含むクロムを有することを特徴とする請求項７に記載のカミソリ刃。

【書類名】　審判請求書
【整理番号】　１３７２２８８０
【提出日】　平成２４年　１月１３日
【あて先】　特許庁長官殿
【審判事件の表示】
　【出願番号】　特願２００１－５６３２８９
　【審判の種別】　拒絶査定に対する審判事件
【請求項の数】　９
【審判請求人】
　【識別番号】　５９３０９３２４９
　【氏名又は名称】　ザ　ジレット　カンパニー
【代理人】
　【識別番号】　１００１１７７８７
　【弁理士】
　【氏名又は名称】　勝沼　宏仁
【選任した代理人】
　【識別番号】　１０００９１９８２
　【弁理士】
　【氏名又は名称】　永井　浩之
【選任した代理人】
　【識別番号】　１００１０７５３７
　【弁理士】
　【氏名又は名称】　磯貝　克臣
【選任した代理人】
　【識別番号】　１００１０５７９５
　【弁理士】
　【氏名又は名称】　名塚　聡

【選任した代理人】
　【識別番号】　１０００９６８９５
　【弁理士】
　【氏名又は名称】　岡　田　淳　平
【選任した代理人】
　【識別番号】　１００１０６６５５
　【弁理士】
　【氏名又は名称】　森　　　秀　行
【選任した代理人】
　【識別番号】　１００１２７４６５
　【弁理士】
　【氏名又は名称】　堀　田　幸　裕
【選任した代理人】
　【識別番号】　１００１５０７１７
　【弁理士】
　【氏名又は名称】　山　下　和　也
　【電話番号】　０３－３２１１－２３２０
　【連絡先】　担当
【手数料の表示】
　【予納台帳番号】　４２５９２６
　【納付金額】　９９０００
【請求の趣旨】　原査定を取り消す、本願は特許をすべきものである、との審決を求める。
【請求の理由】
（１）手続きの経緯
　　国内書面提出日　平成１４年　６月１３日
　　手続補正書　　　平成１９年１２月２６日
　　拒絶理由の通知　平成２２年１１月　５日
　　手続補正書　　　平成２３年　３月　４日

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意見書　　　　　平成２３年　３月　４日

拒絶査定　　　　平成２３年　９月　８日

同　謄本送達　　平成２３年　９月１３日

（２）拒絶査定の要点

（２－１）本願は、請求項１－９に係る発明が、下記の引用文献１－２に記載された発明に基づいて容易に発明することができたものであるから、特許法第２９条第２項の規定により特許を受けることができないというものである。

引用文献１：特開平１１－００９８５７号公報

引用文献２：特表平０６－５０７１００号公報

（２－２）その理由は要するに以下のようなものである。

「出願人は平成２３年３月４日付け手続補正書において、旧請求項１を削除し、旧請求項２を新請求項１とする補正を行った。

そして、同日付け意見書において、引用文献１，２に記載された発明にはいずれにも、ＤＬＣ層とＰＴＦＥ層との間に、クロムの保護膜層が介在されている旨の記載はなく、そのようなことを示唆する旨の記載もない、と主張している。

しかしながら、請求項１については、引用文献１には「大部分のカミソリ刃は、刃の腐食抵抗を増大し、ポリテトラフルオロエチレン（ＰＴＦＥ）のような潤滑性ポリマーの適用に適正なベースを提供するように切断縁上にクロムの薄い層を有する。」（第［０００３］段落）と記載されている。この記載は、ＰＴＦＥ層のベース層としてクロムの薄い層が適正であるということが開示されていると認められる（発明Ａ）。

そして、引用文献１，２に記載された発明には、出願人が意見書でも述べているとおり、ＤＬＣ層にＰＴＦＥ層を設けた点が開示されている（発明Ｂ）。

してみると、発明Ｂに発明Ａを適用して、ＤＬＣ層とＰＴＦＥ層との間にクロムの薄い層を介在することは当業者が容易に想到し得たことである。

その他の請求項については、上記拒絶理由通知書を参照されたい。

したがって、出願人の主張は採用できない。」というものである。

（２－３）他方、請求項１０に係る発明については、現時点では、拒絶の理由

を発見しない旨、認定された。なお、この点については、平成２３年９月８日付け拒絶査定の謄本には明記されていないが、当該拒絶査定を起案された金本審査官殿に、この旨の記載が漏れていたことを平成２３年９月２２日にＴＥＬにて確認している。

（２－４）これに対して本件出願人は明細書の特許請求の範囲を補正するとともに、以下意見を述べる。

（３）手続補正書の概要

本件出願人は、本審判請求書と同日付の手続補正書により、以下のように特許請求の範囲の請求項１を補正した。

「カミソリ刃において、

尖った先端と近傍面とによって規定された切断刃を有する基材と、

前記切断刃上に設けられたハードコーティング層と、

前記ハードコーティング層上に設けられ、物質を含むクロムの保護膜層と、

前記保護膜層上をコーティングするポリテトラフルオロエチレンの外層と、

を備え、

前記ハードコーティングは、物質を含むカーボンから成り、

前記保護膜層は、圧縮応力を受けていることを特徴とするカミソリ刃。」

すなわち、補正前の請求項１に、現時点では拒絶の理由を発見しない旨認定された請求項１０を併合した。

上記補正事項は、当然のことながら、出願当初の明細書の記載および図面の記載に基づいており、特許法第１７条の２第３項に規定する要件を十分に満たすものと思料する。

また、上記補正事項は、特許法第１７条の２第４項第２号に規定する「特許請求の範囲の減縮」を目的としたものであるものと思料する。

（４）本件出願人の意見

本件出願人は、上記審査官殿の認定に沿って特許請求の範囲を補正することにより、本件の特許を取得することに決定した。

すなわち、上記手続補正書により、上述のように現時点では拒絶の理由を発見しない旨認定された補正前の請求項１０を、補正前の請求項１に併合して、独立した新たな請求項１とし、補正前の請求項１０を削除した。

なお、補正前の請求項１０は、補正前の請求項５を引用するように記載されてはいるが、補正前の請求項５を請求項１に併合しない場合であっても、補正後の請求項１には現時点では拒絶の理由を発見しない旨、金本審査官殿に確認していることを付言する。

また、補正後の請求項１によれば、カーボンから成るハードコーティング層と、ポリテトラフルオロエチレンの外層との付着を向上させることができる。また、カミソリ刃は、ハードコーティング層によってもたらされるエッジ強さを向上させて、ひげそりの繰り返しに伴い先端が丸みを帯びることを減少させ、切断抵抗の増加をできる限り抑え、卓越したカミソリ性能を保持することができる。すなわち、カミソリ刃は、最初のひげそり時から卓越したカミソリ特性を保持し続けることができる（本願明細書の段落［０００９］、［００１５］および［００１７］参照）。

このことにより、補正後の請求項１－９は、特許されるべきものと思料する。

（５）結び

上述のように、本願発明は、特許されるべきもの、と思料する。

上記点をご考慮の上、特許すべき旨の審決をお願いいたします。

なお、本件出願人は、上述のように本願発明は特許すべきものと考えるが、審判官殿がなお拒絶の理由は解消していない、と判断した場合、本件出願人は、本件を面接により処理したいと考えております。

この場合は、下記までご連絡下さい。

記

協和特許法律事務所

弁理士　山　下　和　也

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【提出物件の目録】

　【包括委任状番号】　０８１６６１１

# 審査前置移管通知

平成２４年　１月２３日
特　許　庁　長　官

| | |
|---|---|
| 審判請求の番号 | 不服２０１２－　　７１７ |
| （特許出願の番号） | （特願２００１－５６３２８９） |
| 請求人 | ザ ジレット カンパニー 様 |
| 代理人弁理士 | 勝沼 宏仁（外７名）　様 |

この拒絶査定不服審判事件は、特許法第１６２条の規定により審査官に審査（前置審査）させることになりましたのでお知らせします。

審判書記官　　牧口　良一　　7088

# 特許査定

| | |
|---|---|
| 特許出願の番号 | 特願２００１－５６３２８９ |
| 起案日 | 平成２４年　２月２８日 |
| 特許庁審査官 | 金本　誠夫　　３５０５　３Ｃ００ |
| 発明の名称 | カミソリ刃の技術 |
| 請求項の数 | ９ |
| 特許出願人 | ザ　ジレット　カンパニー |
| 代理人 | 勝沼　宏仁（外　７名） |

［前置審査］
原査定を取消す。
この出願については、拒絶の理由を発見しないから、特許査定をします。

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|---|---|---|---|---|
| | 石井　孝明 | 金本　誠夫 | | 中野　裕之 |
| | ９３３７ | ３５０５ | | ４４１８ |

1．出願種別　通常
2．参考文献　有
3．特許法第３０条適用　無
4．発明の名称の変更　無

5．国際特許分類（ＩＰＣ）

Ｂ２６Ｂ　２１／６０

6．菌寄託

7．出願日の遡及を認めない旨の表示

# 参考情報

特許出願の番号　　　　　特願２００１－５６３２８９

１．調査した分野（ＩＰＣ，ＤＢ名）

Ｂ２６Ｂ　　２１／００－２１／６０

２．参考特許文献

特開平１１－００９８５７　　（ＪＰ，Ａ）
特表平０６－５０７１００　　（ＪＰ，Ａ）
米国特許第５７９５６４８　　（ＵＳ，Ａ）

３．参考図書雑誌

P1 330943

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3

**APPLICATION NUMBER:** ***09/515,421***
**FILING DATE:** ***February 29, 2000***
**PCT APPLICATION NUMBER:** *PCT/US01/06206*

(L)60101520570

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1c712 U.S. PTO
09/515421
02/29/00

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1855-1930

W.K. Richardson
1859-1951

February 29, 2000

Attorney Docket No.: 00216-483001

1c781 U.S. PTO
02/29/00

**Box Patent Application**
Assistant Commissioner for Patents
Washington, DC 20231

BOSTON
DELAWARE
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SAN DIEGO
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Presented for filing is a new original patent application of:

Applicant: NEVILLE SONNENBERG, ANDREW ZHUK, CHARLES WHITE, STEVEN HAHN AND COLIN CLIPSTONE

Title: RAZOR BLADE TECHNOLOGY

Enclosed are the following papers, including those required to receive a filing date under 37 CFR 1.53(b):

| | Pages |
|---|---|
| Specification | 5 |
| Claims | 4 |
| Abstract | 1 |
| Declaration | [To be Filed at a Later Date] |
| Drawing(s) | 1 |

Enclosures:
— Postcard.

| | |
|---|---|
| Basic filing fee | $690 |
| Total claims in excess of 20 times $18 | $306 |
| Independent claims in excess of 3 times $78 | $78 |
| Fee for multiple dependent claims | $260 |
| Total filing fee: | $1334 |

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EL228033446

I hereby certify under 37 CFR §1.10 that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addressee with sufficient postage on the date indicated below and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

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3

Assistant Commissioner for Patents
February 29, 2000
Page 2

A check for the filing fee is enclosed. Please apply any other required fees or any credits to deposit account 06-1050, referencing the attorney docket number shown above.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (617) 542-5070.

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WILLIAM E. BOOTH
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Respectfully submitted,

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4

Attorney Docket No. 00216-483001

# Razor Blade Technology

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and polytetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

## Summary of the Invention

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
**WO 01/64406 A2**

(51) International Patent Classification[7]: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,421 29 February 2000 (29.02.2000) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/515,421 (CON)
Filed on 29 February 2000 (29.02.2000)

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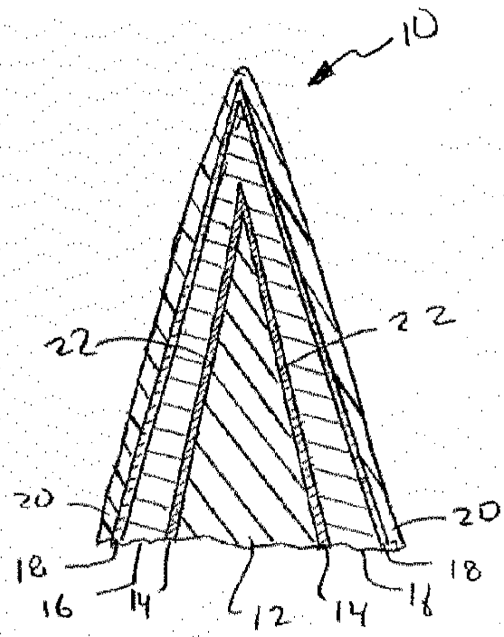
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

*[Continued on next page]*

(54) Title: RAZOR BLADE TECHNOLOGY




(57) Abstract: A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

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**WO 01/64406 A2**

DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

**(84) Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *without international search report and to be republished upon receipt of that report*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

RAZOR BLADE TECHNOLOGY

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond; amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and polytetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

Particular embodiments of the invention may include one or more of

the following features. In particular embodiments, the hard coating material can be made of carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides, carbides, oxides or other ceramics. The hard coating layer can have a thickness less than 2,000 angstroms. The overcoat layer can be made of chromium or a chromium containing alloy compatible with polytetrafluoroethylene such as a chromium platinum alloy. The overcoat layer can be between 100 and 500 angstroms thick. The blade can include an interlayer between the substrate and the layer of hard coating. The interlayer can include niobium or a chromium containing material. The polytetrafluoroethylene can be Krytox LW1200 available from DuPont. The PTFE outer layer can be between 100 and 5000 angstroms thick.

In another aspect, the invention features, in general, making a razor blade by providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets, adding a layer of hard coating on the cutting edge, adding an overcoat layer of a chromium containing material on the layer of hard coating, and adding an outer layer of polytetrafluoroethylene coating over the overcoat layer.

Particular embodiments of the invention may include one or more of the following features. In particular embodiments the layers can be added by physical vapor deposition (i.e., sputtering) or by chemical vapor deposition. The chromium containing layer, preferably chromium, can be sputter deposited under conditions that result in a compressively stressed coating. The sputter deposition of chromium containing materials can include applying a DC bias to the target that is more negative than -50 volts, preferably more negative than -200 volts. Alternatively an appropriate RF bias scheme can be used to achieve an equivalent chromium layer.

Embodiments of the invention may include one or more of the following advantages. The use of a chromium containing overcoat layer provides improved adhesion of the polytetrafluorethylene outer layer to the hard coating layer. The razor blade has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves. Reduced tip rounding minimizes the increase in cutting force thereby maintaining excellent shaving performance. The razor blade has excellent shaving characteristics from the first shave onwards.

Other features and advantages of the invention will be apparent from

the following description of a particular embodiment and from the claims.

FIG. 1 is a vertical sectional view of a cutting edge portion of a razor blade.

FIG. 2 is a perspective view of a shaving razor including the FIG. 1 razor blade.

Referring to FIG. 1, there is shown razor blade 10 including substrate 12, interlayer 14, hard coating layer 16, overcoat layer 18, and outer layer 20. The substrate 12 is typically made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 22 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium containing material. A particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard coating layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides (e.g., boron nitride, niobium nitride or titanium nitride), carbides (e.g., silicon carbide), oxides (e.g., alumina, zirconia) or other ceramic materials. The carbon containing materials can be doped with other elements, such as tungsten, titanium or chromium by including these additives, for example in the target during application by sputtering. The materials can also incorporate hydrogen, e.g., hydrogenated DLC. Preferably coating layer 16 is made of diamond, amorphous diamond or DLC. A particular embodiment includes DLC less than 2,000 angstroms, preferably less than 1,000 angstroms. DLC layers and methods of deposition are described in U.S. Patent No. 5,232,568. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond.

Overcoat layer 18 is used to reduce the tip rounding of the hard

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coated edge and to facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 18 is preferably made of chromium containing material, e.g., chromium or chromium alloys that are compatible with polytetrafluoroethylene, e.g., CrPt. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer.

Outer layer 20 is used to provide reduced friction and includes polytetrafluoroethylene and is sometimes referred to as a telomer. A particular polytetrafluoroethylene material is Krytox LW 1200 available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a niobium interlayer 14, DLC hard coating layer 16, chromium overcoat layer 18, and Krytox LW1200 polytetrafluoroethylene outer coat layer 20. Chromium overcoat layer 18 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200 - 400 angstroms, measured by SEM after application of overcoat layer 18 and before adding outer layer 20.

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Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

In use, razor blade 10 has excellent shaving characteristics from the first shave onwards. Blade 10 has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves provided by the overlayer coating while maintaining excellent shave characteristics.

Other embodiments of the invention are within the scope of the appended claims.

## CLAIMS

1. A razor blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. The blade of claim 1, wherein said hard coating is made of a carbon containing material.

3. The blade of claim 2, wherein said carbon containing material comprises diamond.

4. The blade of claim 2, wherein said hard carbon coating comprises diamond-like carbon material.

5. The blade of claim 2, wherein said hard carbon coating comprises amorphous diamond material.

6. The blade of claim 1, wherein said overcoat layer consists of chromium.

7. The blade of claim 1, wherein said overcoat layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

8. The blade of claim 4, wherein said overcoat layer consists of chromium.

9. The blade of claim 7, wherein said alloy is a chromium platinum alloy.

10. The blade of claim 1, further comprising an interlayer between said substrate and said layer of hard carbon coating.

11. The blade of claim 10, wherein said interlayer comprises niobium.

12. The blade of claim 10, wherein said interlayer comprises a chromium containing material.

13. The blade of claim 6, 7, 8, or 9, wherein said overcoat layer is compressively stressed.

14. The blade of claim 1, wherein said polytetrafluoroethylene is Krytox LW1200.

15. The blade of claim 4, further comprising a niobium interlayer between said substrate and said hard coating.

16. The blade of claim 8, wherein said polytetrafluoroethylene is Krytox LW1200.

17. The blade of claim 1, wherein said hard coating layer has a thickness less than 2,000 angstroms.

18. The blade of claim 1, wherein said overcoat layer is between 100 and 500 angstroms thick.

19. The blade of claim 1, wherein said outer layer is between 100 and 5,000 angstroms thick.

20. The blade of claim 1, 8, 16 or 17, wherein said blade has a cutting edge that has less rounding with repeated shaves than it would have without said overcoat layer.

21. A shaving razor comprising:

a handle,

a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. The razor of claim 21, wherein said hard coating is made of a carbon containing material.

23. The razor of claim 22, further comprising a niobium interlayer between said substrate and said hard coating.

24. The razor of claim 21 or 22, wherein said overcoat layer consists of

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chromium.

25. A method of making a razor blade comprising:

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

26. The method of claim 25, wherein said adding a layer of hard coating includes vapor depositing a carbon containing material.

27. The method of claim 25, wherein said adding a layer of chromium containing material includes vapor depositing said chromium containing material.

28. The method of claim 27, wherein said adding a layer of chromium containing material includes sputter depositing under conditions to result in compressively stressed material.

29. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -50 volts or an equivalent RF bias scheme.

30. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -200 volts or an equivalent RF bias scheme.

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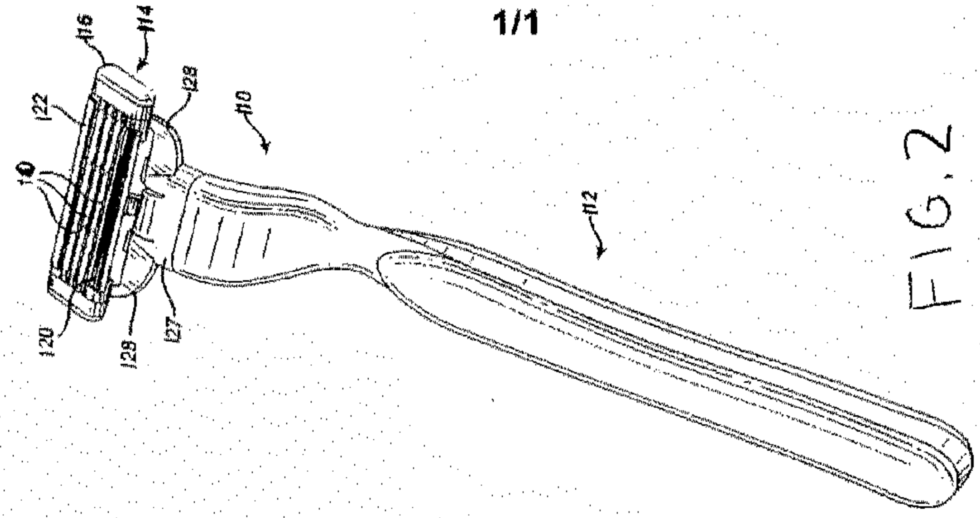
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FIG. 2

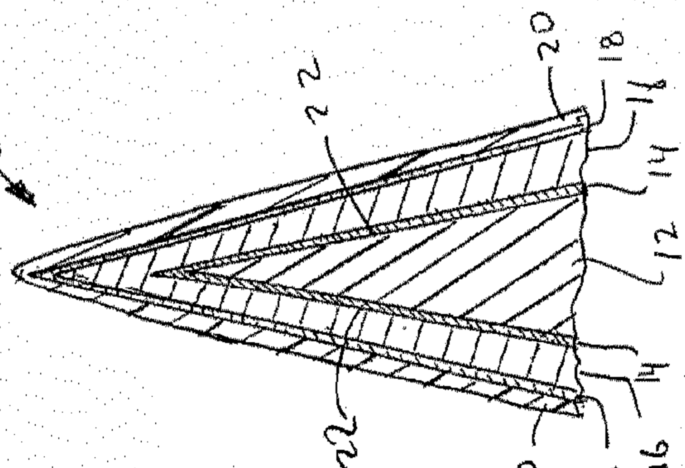
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FIG. 1

【書類名】　外国語国際公開図面（職権）

【事件の表示】

　【出願の区分】　特許

　【国際出願番号】　PCT/US01/06206

　【国際出願日】　平成13年 2月27日提出

【提出物件の目録】

　【物件名】　図面　1

【書類名】　　　　　図面

【ＦＩＧ１】

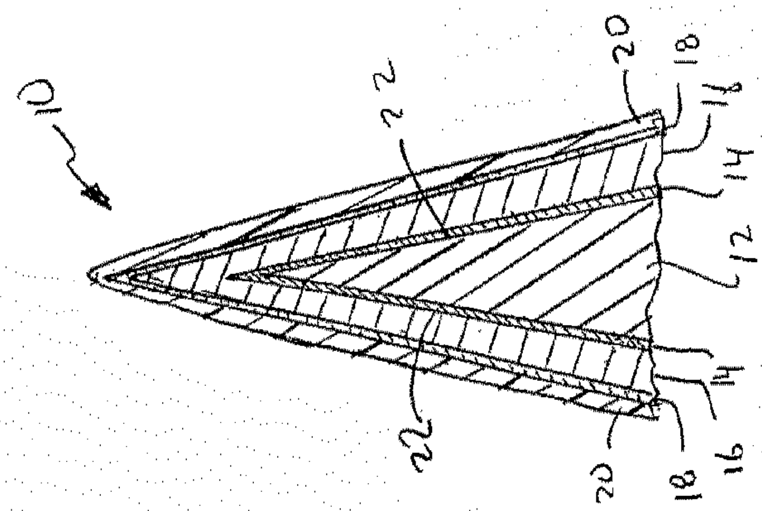


FIG.1

【ＦＩＧ２】

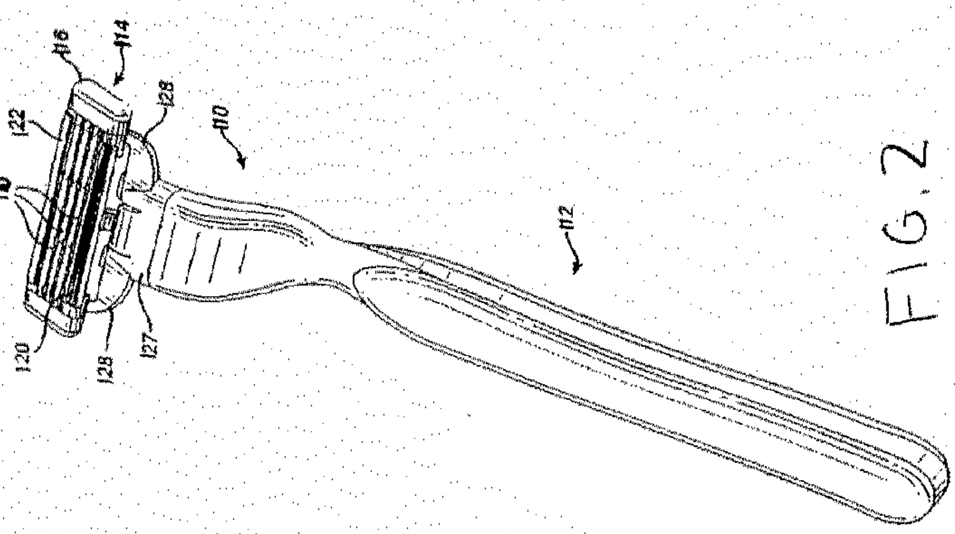


FIG.2

01.11.26

PCT/US01/06206

(L)60102061361

PATENT COOPERATION TREATY

FROM THE INTERNATIONAL BUREAU

TO:

Japanese Patent Office
Tokyo

IN ITS CAPACITY AS ELECTED OFFICE

# PCT

NOTIFICATION OF ELECTION

(PCT RULE 61.2)

| | |
|---|---|
| DATE OF MAILING: 30 OCTOBER 2001 (30.10.01) | |
| INTERNATIONAL APPLICATION NO.: PCT/US01/06206 | APPLICANT'S OR AGENT'S FILE REFERENCE: 8073 |
| INTERNATIONAL FILING DATE: 27 FEBRUARY 2001 (27.02.01) | PRIORITY DATE: 29 FEBRUARY 2000 (29.02.00) |
| APPLICANT: THE GILLETTE COMPANY | |

1. THE DESIGNATED OFFICE IS HEREBY NOTIFIED OF ITS ELECTION MADE:

[*] IN THE DEMAND FILED WITH THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY ON:

12 JULY 2001 (12.07.01)

[ ] IN A NOTICE EFFECTING LATER ELECTION FILED WITH THE INTERNATIONAL BUREAU ON:

2. THE ELECTION [*] WAS

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| FACSIMILE NO.:(41-22)740.14.35 | TELEPHONE NO.:(41-22)730.91.11 |

FORM PCT/IB/331(JULY 1992)

004411027

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/64406 A3

(51) International Patent Classification[7]: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,421 29 February 2000 (29.02.2000) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/515,421 (CON)
Filed on 29 February 2000 (29.02.2000)

(71) Applicant (*for all designated States except US*): THE GILLETTE COMPANY [US/US]; Prudential Tower Building, Boston, MA 02199 (US).

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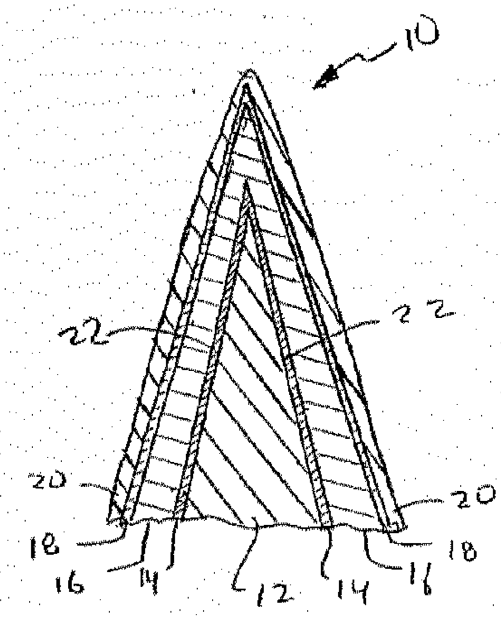
(75) Inventors/Applicants (*for US only*): SONNENBERG, Neville [US/US]; 101 Hanson Road, Newton, MA 02459 (US). ZHUK, Andrew [RU/US]; 117 Central Street, Apt. F-11, Acton, MA 01720 (US). WHITE, Charles [US/US]; 72 Forest Hill Avenue, Lynnfield, MA 01940 (US). HAHN, Steven [US/US]; 7 Trinity Court, Wellesley, MA 02481 (US). CLIPSTONE, Colin, John [GB/US]; 154 Newton Street, Weston, MA 02493 (US).

(74) Agents: GALLOWAY, Peter, D.; Ladas & Parry, 26 West 61st Street, New York, NY 10023 et al. (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

[Continued on next page]

(54) Title: RAZOR BLADE TECHNOLOGY




(57) Abstract: A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

WO 01/64406 A3

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**WO 01/64406 A3**

DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

**(84) Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*

**(88) Date of publication of the international search report:** 7 February 2002

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/06206

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26B21/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 3 743 551 A (SANDERSON M) 3 July 1973 (1973-07-03)<br>the whole document | 1,7, 17-19, 21,25 |
| Y | US 5 669 144 A (BROOKS LAMAR EUGENE ET AL) 23 September 1997 (1997-09-23)<br>cited in the application<br>column 3, line 61 -column 4, line 13; claims 15,20 | 1,7, 17-19, 21,25 |
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| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 3 September 2001 | 10/09/2001 |
| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br><br>Herijgers, J |

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PACE-037595

**INTERNATIONAL SEARCH REPORT**

International Application No
PCT/US 01/06206

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No
PCT/US 01/06206

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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Form PCT/ISA/210 (patent family annex) (July 1992)



PACE-037597

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 01/06206

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
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Form PCT/ISA/210 (patent family annex) (July 1992)



PACE-037598

(L)60201990328

# PATENT COOPERATION TREATY

# PCT

REC'D 04 JUN 2002
WIPO PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| | | |
|---|---|---|
| Applicant's or agent's file reference<br>8073 | **FOR FURTHER ACTION** | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
| International application No.<br>PCT/US01/06206 | International filing date *(day/month/year)*<br>27/02/2001 | Priority date *(day/month/year)*<br>29/02/2000 |
| International Patent Classification (IPC) or national classification and IPC<br>B26B21 | | |
| Applicant<br>THE GILLETTE COMPANY et al. | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

| | |
|---|---|
| Date of submission of the demand<br>12/07/2001 | Date of completion of this report<br>04.06.2002 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office - P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk - Pays Bas<br>Tel. +31 70 340 - 2040 Tx: 31 651 epo nl<br>Fax: +31 70 340 - 3016 | Authorized officer<br>Herijgers, J<br>Telephone No. +31 70 340 2226 |

Form PCT/IPEA/409 (cover sheet) (January 1994)

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**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

International application No. PCT/US01/06206

**I. Basis of the report**

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
**Description, pages:**

1-5 as originally filed

**Claims, No.:**

1-30 as originally filed

**Drawings, sheets:**

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:

3

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US01/06206

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-30 |
| | No: | Claims | |
| Inventive step (IS) | Yes: | Claims | 2-6,8-16,20,22-25,26-30 |
| | No: | Claims | 1,7,17-19,21,25 |
| Industrial applicability (IA) | Yes: | Claims | 1-30 |
| | No: | Claims | |

2. Citations and explanations
**see separate sheet**

Re Item V

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:
   D1: US-A-3743551
   D2: US-A-5669144

2. Document D1, which is considered to represent the most relevant state of the art, discloses (see claim 1) a razor blade comprising a substrate with a cutting edge, a layer of hard coating (lower coating of chromium) on said cutting edge, an overcoat layer of chromium containing material (upper coating of chromium nitride) on said layer of hard coating, and an outer layer of polytetrafluoroethylene coating over said overcoat layer (see claim 8). The subject-matter of claim 1 differs in that the cutting edge is defined by a sharpened tip and adjacent facets. However such cutting edges are generally known, see e.g. D2.
   In view of the previous paragraph, the skilled person would regard it a normal design procedure to combine all the features set out in claim 1. Thus, the subject-matter of claim 1 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

3. The feature of claim 7 is also disclosed by D1, polytetrafluoroethylene being provided on the chromium nitride implies that they are compatible.
   The features of claims 17 to 19 are also disclosed by D1 (see col. 1 lines 53-55). Hence claims 7, and 17 to 19 lack also an inventive step.

4. The same reasoning as set forth in point 2 above leads to the conclusion that claims 21 and 25 also lack an inventive step.

5. The combinations of the features of dependent claims 2, 22 and 26 are neither known from, nor rendered obvious by, the available prior art.The chromium containing overcoat layer over a carbon containing hard layer improves the adhesion of PTFE onto the carbon containing hard layer. Hence these claims and their dependent claims are novel and inventive.

# Exhibit 4

03-05-03 10379264 .030403

A

JC759 U.S. PTO 03/04/03

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WASHINGTON, DC

March 4, 2003

Attorney Docket No.: 00216-607001

J1033 U.S. PTO 10/379264 03/04/03

**Box Patent Application**
Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicant: COLIN CLIPSTONE, STEVE S. HAHN, YIQIAN ERIC LIU, NEVILLE SONNENBERG AND ANDREW ZHUK

Title: RAZOR BLADE

Enclosed are the following papers, including those required to receive a filing date under 37 CFR §1.53(b):

| | Pages |
|---|---|
| Specification | 5 |
| Claims | 3 |
| Abstract | 1 |
| Declaration | 2 |
| Drawing(s) | 2 |

Enclosures:
— Postcard.

| | |
|---|---|
| Basic filing fee | $750 |
| Total claims in excess of 20 times $18 | $108 |
| Independent claims in excess of 3 times $84 | $252 |
| Fee for multiple dependent claims | $280 |
| Total filing fee: | $1390 |

A check for the filing fee is enclosed. Please apply any other required fees or any credits to deposit account 06-1050, referencing the attorney docket number shown above.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (617) 542-5070.

Kindly acknowledge receipt of this application by returning the enclosed postcard.

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EL 947 902 722 US

March 4, 2003
Date of Deposit

[redacted]

PACE-037265

FISH & RICHARDSON P.C.

Commissioner for Patents
March 4, 2003
Page 2

Please direct all correspondence to the following customer number:

PTO Customer No: 26161

Respectfully submitted,

Robert C. Nabinger
Reg. No. 33,431
Enclosures
RCN/slh
20589550.doc

[redacted]

10379264.030403

Attorney's Docket No.: 00216-607001 / Case 8104

# APPLICATION

# FOR

# UNITED STATES LETTERS PATENT

TITLE: RAZOR BLADE

APPLICANT: COLIN CLIPSTONE, STEVE S. HAHN, YIQIAN ERIC LIU, NEVILLE SONNENBERG AND ANDREW ZHUK

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EL 947 902 722 US

March 4, 2003
Date of Deposit

[redacted]

PACE-037267

# Razor Blade

## TECHNICAL FIELD

The invention relates to razors and razor blades.

## BACKGROUND

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC), nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the adhesion between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; PCT 92/03330, and PCT 01/64406, which are hereby incorporated by reference.

It is known that an overlayer of chromium can be used between the hard carbon coating and the PTFE outer layer.

## SUMMARY

Generally, the invention features a razor blade including a cutting edge defined by a sharpened tip and adjacent facets. The cutting edge includes a coating of a carbon-containing material (for example, DLC) including a dopant. The dopant may be silicon or a metal such as chromium, titanium, molybdenum, niobium, or tungsten. The carbon-containing material preferably includes from 1 to 10 atomic percent, and more preferably from 1 to 5 atomic percent, of the dopant.

In one embodiment, the dopant is chromium and the razor blade further includes a coating of PTFE on the coating of carbon-containing material without any intervening layer (for example, a chromium overlayer).



[redacted]

In another embodiment, the dopant again is chromium and the razor blade does not include an interlayer between the cutting edge and the coating of carbon-containing material. The razor blade also may include a coating of PTFE and, optionally, an overlayer between the coating of carbon-containing material and the coating of PTFE.

The invention also features razors including razor blades having the coating of carbon-containing material including a dopant. In some embodiments, the dopant provides the razor blade with improved thermal stability and wear resistance.

The invention also features making razor blades including a carbon-containing material including a dopant. In one embodiment, a razor blade is made by adding a coating of a carbon-containing material including a dopant (preferably chromium) to the cutting edge. A coating of PTFE then is added directly to the coating of carbon-containing material by contacting the coating of carbon-containing material with an aqueous dispersion of PTFE.

Other features and advantages of the invention will be apparent from the following description of embodiments and from the claims.

## DESCRIPTION OF DRAWINGS

FIG. 1 is a vertical sectional view of a cutting edge portion of an embodiment of a razor blade;

FIG. 2 is a perspective view of a razor including the Fig. 1 razor blade; and

FIG. 3 is a vertical sectional view of a cutting edge portion of an alternate embodiment of a razor blade.

## DETAILED DESCRIPTION

Referring to FIG. 1, razor blade 10 includes substrate 12, interlayer 14, hard carbon layer 16, and outer layer 18. Substrate 12 typically is made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 20 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium-containing materials. A



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particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard carbon layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon-containing materials such as diamond, amphorous diamond, and DLC that have been doped with chromium. The carbon-containing material is doped with chromium by including chromium in the target during application of the carbon layer during sputtering. The chromium may be chromium metal or, for example, an alloy of chromium such as CrPt. The carbon-containing material preferably includes from 0.1 to 10 atomic percent chromium, and more preferably from 0.5 to 7 atomic percent or 1 to 5 atomic percent chromium. The carbon-containing material can also incorporate hydrogen, for example, hydrogenated DLC.

A particular embodiment of a hard carbon layer is DLC doped with 2 atomic percent chromium. The layer preferably is less than 2,000 angstroms thick, and more preferably less than 1,000 angstroms think. DLC coatings and methods of depositions are described in U.S. Pat. 5,232,568, which is hereby incorporated by reference. The general procedure described in U.S. Pat. 5,232,568 is modified in that a graphite target doped with 2 atomic percent chromium was used in place of a pure graphite target. The chromium-doped DLC layer can be applied, for example, by using sputtering using a DC bias of about -500 volts and a pressure of about 2 mtorr. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amphorous carbon material that exhibits many of the desirable properties but does not have the crystalline structure of diamond.

Outer layer 18 provides reduced friction and includes PTFE and is sometimes referred to as a telomer. A preferred PTFE material is Krytox LW 1200, available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of about 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air-dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.



[redacted]

The polytetrafluoroethylene layer adheres well to the chromium-doped DLC layer even though the polytetrafluoroethylene was applied directly to the chromium-doped DLC layer as an aqueous dispersion. It is believed that the chromium dopant aids in the adhesion between the layers.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a 200 angstroms thick niobium interlayer 14, a 700 angstroms thick chromium-doped DLC layer 16, and a 200 angstroms thick Krytox LW1200 polytetrafluoroethylene outer coat layer 18. Blade 10 preferably has a tip radius of about 200- 400 angstroms, measured by SEM before adding outer layer 18.

Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 114 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two, three, or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

Referring to FIG. 3, an alternative razor blade 22 includes substrate 12, hard carbon layer, 16, overcoat layer 24, and outer layer 18. The substrate, hard carbon layer, and outer layer generally are the same as in razor blade 10.

Overcoat layer 24 is discussed in U.S.S.N. 09/515,421, which is hereby incorporated by reference. The overcoat layer reduces the tip rounding of the hard coated edge and can facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 24 is preferably made of chromium containing material, e.g., chromium or chromium alloys, e.g. CrPt, that are compatible with polytetrafluoroethylene. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer. Chromium overcoat layer 24 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased



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negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200- 400 angstroms, measured by SEM after application of overcoat layer 24 and before adding outer layer 20.

Hard carbon layer 16, which is doped with chromium, adheres to substrate 12 even though the hard carbon layer is deposited directly on the substrate, without an interlayer. It is believed that the presence of the chromium dopant aids in the adhesion between the hard carbon layer and the cutting edge.

Other embodiments are within the claims. For example, the razor blade optionally may include neither an interlayer 14 nor an overcoat layer 24. In addition, titanium, niobium, tungsten, molybdenum, or silicon may be used in place of, or in addition to chromium, as the dopant in the hard carbon material.

Moreover, the razor blade may include two or more hard carbon layers. Each layer can include a different quantity of dopant and one or more layers may include no dopant. The hard carbon layers may include the same or different carbon-containing material.

For example, a hard carbon-containing layer may include a variable quantity of dopant. For example, the inner surface of the hard carbon layer may include 1 atomic percent dopant, and that quantity may increase among a gradient, with the outer surface of the hard carbon layer including 5 or 10 atomic percent of the dopant.

In addition, a hard carbon-containing layer may include two or more dopants selected, for example, from those mentioned previously.

Other embodiments are within the claims.



[redacted]

**WHAT IS CLAIMED IS:**

1. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating of a carbon-containing material, doped with chromium, on the cutting edge; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.

2. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating of a carbon-containing material, doped with chromium, on the cutting edge; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

3. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material includes from 0.1 to 10 atomic percent chromium.
4. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material includes from 1 to 5 atomic percent chromium.
5. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material is diamond-like carbon.
6. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material is selected from the group consisting of diamond and amphorous diamond.
7. The razor blade of claim 1, further comprising an interlayer between the coating of a carbon-containing material and the cutting edge.
8. The razor blade of claim 7, wherein the interlayer comprises niobium.
9. The razor blade of claim 2, further comprising an overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.
10. The razor blade of claim 9, wherein the overcoat layer comprises chromium.



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11. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. A shaving razor comprising

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the a coating of a carbon-containing material;

wherein there is no overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.

13. A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14. A method of making a razor blade comprising

coating a substrate having a cutting edge defined by a sharpened tip and adjacent facets with a carbon-containing material doped with chromium; and

coating the coating of carbon-containing material with polytetrafluoroethylene by contacting the coating of a carbon-containing material directly with an aqueous dispersion including polytetrafluoroethylene.

15. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets; and

a coating of diamond-like carbon on the cutting edge, the coating including from 0.1 to 10 atomic percent of a dopant.



[redacted]

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16. The razor blade of claim 15, wherein the coating includes from 1 to 5 atomic percent of a dopant.
17. The razor blade of claim 15, wherein the dopant is selected from the group consisting of titanium, niobium, tungsten, molybdenum, and silicon.
18. The razor blade of claim 17, wherein the dopant is selected from the group consisting of niobium, molybdenum, and silicon.
19. The razor blade of claim 17, wherein the dopant is chromium.
20. The razor blade of claim 15, further comprising an interlayer between the coating of diamond-like carbon and the cutting edge.
21. The razor blade of claim 15, further comprising a coating of polytetrafluoroethylene on the coating of diamond-like carbon.



[redacted]

## ABSTRACT

A razor blade includes a substrate with a cutting edge and a coating of a carbon-containing material doped, for example, with chromium.

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FIG. 1

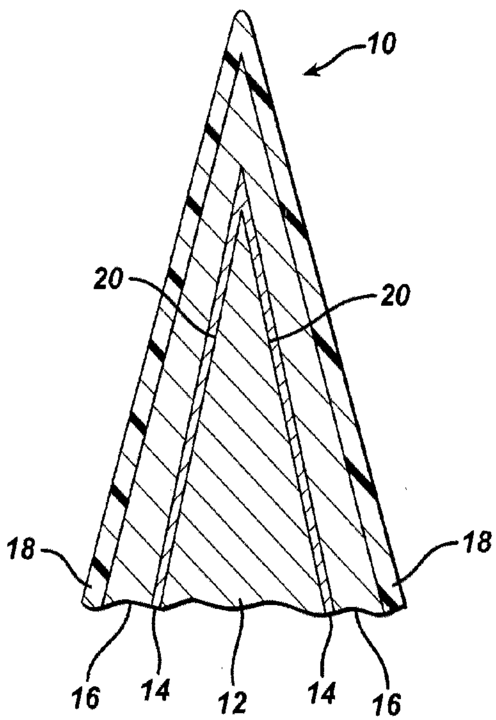
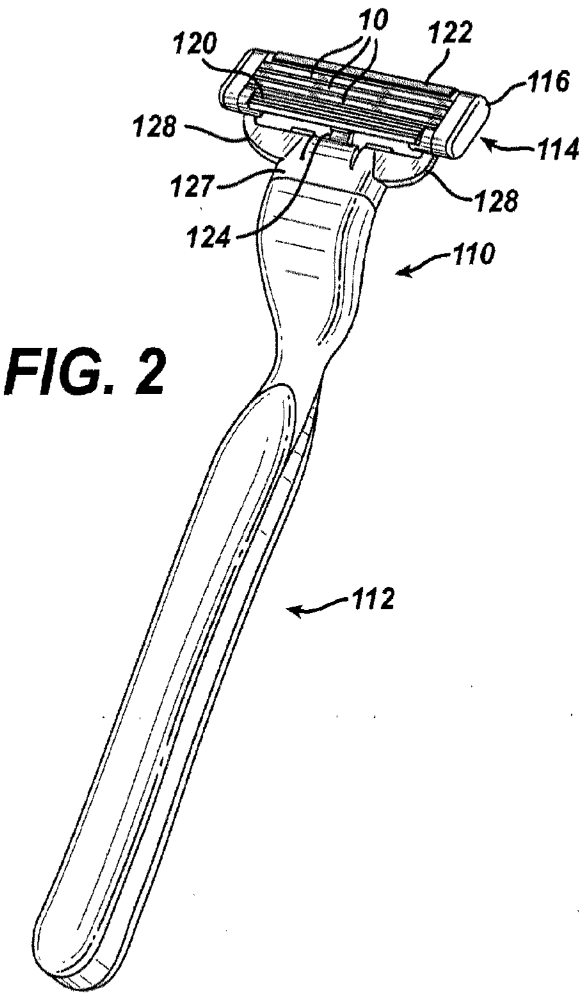



FIG. 2

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RAZOR BLADE
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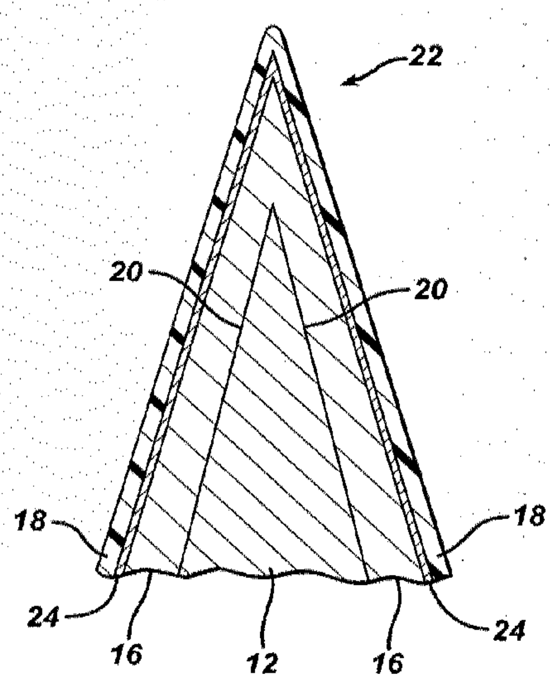
FIG. 3



Docket No. 00216-607001

# COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name;

I believe I am the original, first, and sole inventor (if only one name is listed below), or an original, first, and joint inventor (if plural names are listed below), of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**Razor Blade**

the specification of which

X is attached hereto.
__ was filed on as Application Serial No.
__ was filed as PCT International Application No. ________ on ________

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which I know is material to patentability as defined in 37 C.F.R. §1.56.

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and to file and prosecute national, international, and regional applications which claim priority from this application:

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[redacted]

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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U.S. **UTILITY** Patent Application

| PATENT NUMBER and ISSUE DATE |
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**APPLICANTS: Clipstone Colin; Hahn Steve; Liu Yiqian; Sonnenberg Neville; Zhuk Andrew;

13 30/346.54

Fig 1

**CONTINUING DATA VERIFIED:

** FOREIGN APPLICATIONS VERIFIED:

PG-PUB DO NOT PUBLISH ☐ RESCIND ☐

| | | ATTORNEY DOCKET NO |
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| Foreign priority claimed | ☐ yes ☐ no | |
| 35 USC 119 conditions met | ☐ yes ☐ no | 00216-607001 |
| Verified and Acknowledged Examiners's Intials | | |

TITLE : Razor blade

U.S.DEPT. OF COMM./PAT & TM-PTO-436L(Rev. 12-94)

| NOTICE OF ALLOWANCE MAILED | | CLAIMS ALLOWED | |
|---|---|---|---|
| | Assistant Examiner | Total Claims | Print Claim for O.G |
| ISSUE FEE | | DRAWING | |
| Amount Due / Date Paid | Primary Examiner | Sheets Drwg. / Figs.Drwg. / Print Fig. | Application Examiner |
| ☐ TERMINAL DISCLAMER | PREPARED FOR ISSUE | | |

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## SEARCH

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## SEARCH NOTES

(List databases searched. Attach search strategy inside.)

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## ISSUING CLASSIFICATION

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## INDEX OF CLAIMS

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10/379264
03/04/03

March 4, 2003

Attorney Docket No.: 00216-607001

**Box Patent Application**
Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicant: COLIN CLIPSTONE, STEVE S. HAHN, YIQIAN ERIC LIU, NEVILLE SONNENBERG AND ANDREW ZHUK

Title: RAZOR BLADE

Enclosed are the following papers, including those required to receive a filing date under 37 CFR §1.53(b):

| | Pages |
|---|---|
| Specification | 5 |
| Claims | 3 |
| Abstract | 1 |
| Declaration | 2 |
| Drawing(s) | 2 |

Enclosures:
— Postcard.

| | |
|---|---|
| Basic filing fee | $750 |
| Total claims in excess of 20 times $18 | $108 |
| Independent claims in excess of 3 times $84 | $252 |
| Fee for multiple dependent claims | $280 |
| Total filing fee: | $1390 |

A check for the filing fee is enclosed. Please apply any other required fees or any credits to deposit account 06-1050, referencing the attorney docket number shown above.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (617) 542-5070.

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Respectfully submitted,

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Enclosures
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FIG. 1

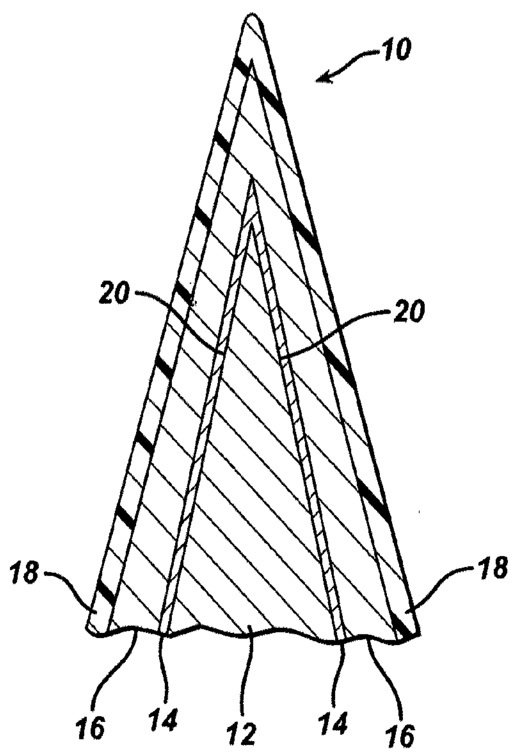
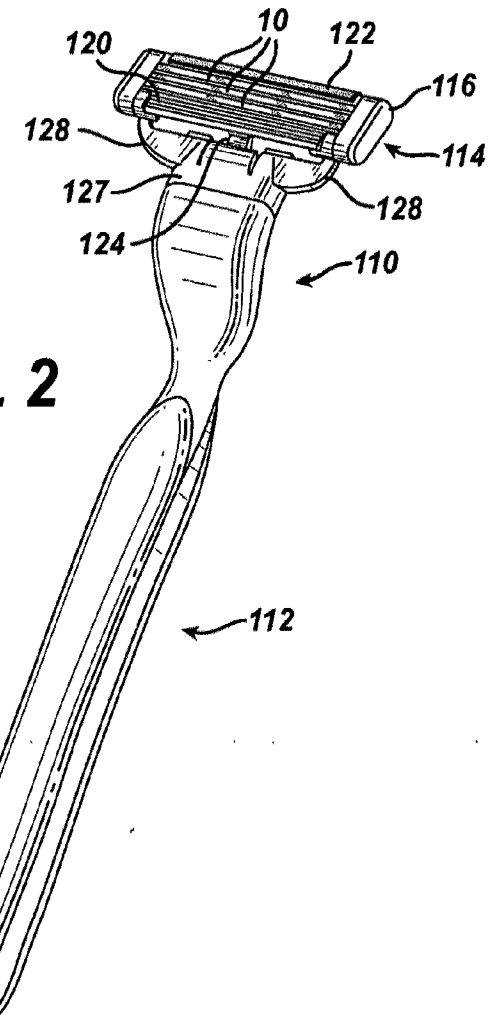



FIG. 2

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RAZOR BLADE
Colin Clipstone et al.
00216-607001

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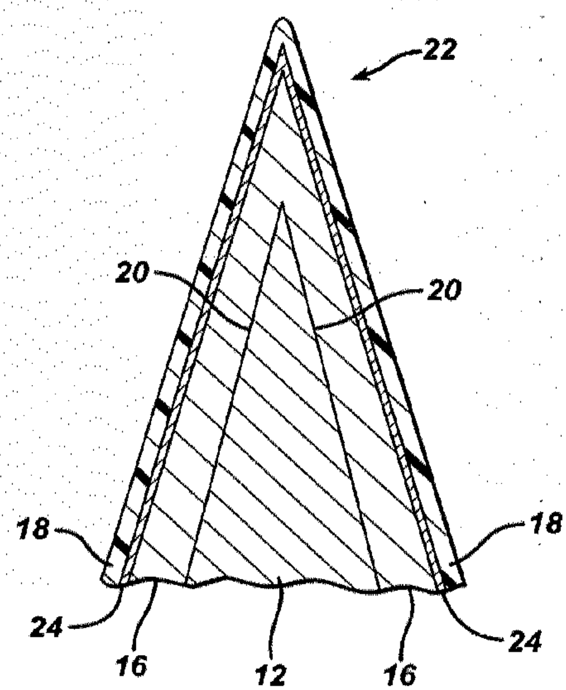
FIG. 3



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Attorney's Docket No.: 00216-607001 / Case 8104

# APPLICATION

# FOR

# UNITED STATES LETTERS PATENT

TITLE: RAZOR BLADE

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CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EL 947 902 722 US

March 4, 2003
Date of Deposit

# Razor Blade

## TECHNICAL FIELD

The invention relates to razors and razor blades.

## BACKGROUND

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC), nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the adhesion between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; PCT 92/03330, and PCT 01/64406, which are hereby incorporated by reference.

It is known that an overlayer of chromium can be used between the hard carbon coating and the PTFE outer layer.

## SUMMARY

Generally, the invention features a razor blade including a cutting edge defined by a sharpened tip and adjacent facets. The cutting edge includes a coating of a carbon-containing material (for example, DLC) including a dopant. The dopant may be silicon or a metal such as chromium, titanium, molybdenum, niobium, or tungsten. The carbon-containing material preferably includes from 1 to 10 atomic percent, and more preferably from 1 to 5 atomic percent, of the dopant.

In one embodiment, the dopant is chromium and the razor blade further includes a coating of PTFE on the coating of carbon-containing material without any intervening layer (for example, a chromium overlayer).

In another embodiment, the dopant again is chromium and the razor blade does not include an interlayer between the cutting edge and the coating of carbon-containing material. The razor blade also may include a coating of PTFE and, optionally, an overlayer between the coating of carbon-containing material and the coating of PTFE.

The invention also features razors including razor blades having the coating of carbon-containing material including a dopant. In some embodiments, the dopant provides the razor blade with improved thermal stability and wear resistance.

The invention also features making razor blades including a carbon-containing material including a dopant. In one embodiment, a razor blade is made by adding a coating of a carbon-containing material including a dopant (preferably chromium) to the cutting edge. A coating of PTFE then is added directly to the coating of carbon-containing material by contacting the coating of carbon-containing material with an aqueous dispersion of PTFE.

Other features and advantages of the invention will be apparent from the following description of embodiments and from the claims.

## DESCRIPTION OF DRAWINGS

FIG. 1 is a vertical sectional view of a cutting edge portion of an embodiment of a razor blade;

FIG. 2 is a perspective view of a razor including the Fig. 1 razor blade; and

FIG. 3 is a vertical sectional view of a cutting edge portion of an alternate embodiment of a razor blade.

## DETAILED DESCRIPTION

Referring to FIG. 1, razor blade 10 includes substrate 12, interlayer 14, hard carbon layer 16, and outer layer 18. Substrate 12 typically is made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 20 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium-containing materials. A



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particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard carbon layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon-containing materials such as diamond, amphorous diamond, and DLC that have been doped with chromium. The carbon-containing material is doped with chromium by including chromium in the target during application of the carbon layer during sputtering. The chromium may be chromium metal or, for example, an alloy of chromium such as CrPt. The carbon-containing material preferably includes from 0.1 to 10 atomic percent chromium, and more preferably from 0.5 to 7 atomic percent or 1 to 5 atomic percent chromium. The carbon-containing material can also incorporate hydrogen, for example, hydrogenated DLC.

A particular embodiment of a hard carbon layer is DLC doped with 2 atomic percent chromium. The layer preferably is less than 2,000 angstroms thick, and more preferably less than 1,000 angstroms think. DLC coatings and methods of depositions are described in U.S. Pat. 5,232,568, which is hereby incorporated by reference. The general procedure described in U.S. Pat. 5,232,568 is modified in that a graphite target doped with 2 atomic percent chromium was used in place of a pure graphite target. The chromium-doped DLC layer can be applied, for example, by using sputtering using a DC bias of about -500 volts and a pressure of about 2 mtorr. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amphorous carbon material that exhibits many of the desirable properties but does not have the crystalline structure of diamond.

Outer layer 18 provides reduced friction and includes PTFE and is sometimes referred to as a telomer. A preferred PTFE material is Krytox LW 1200, available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of about 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air-dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.



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The polytetrafluoroethylene layer adheres well to the chromium-doped DLC layer even though the polytetrafluoroethylene was applied directly to the chromium-doped DLC layer as an aqueous dispersion. It is believed that the chromium dopant aids in the adhesion between the layers.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a 200 angstroms thick niobium interlayer 14, a 700 angstroms thick chromium-doped DLC layer 16, and a 200 angstroms thick Krytox LW1200 polytetrafluoroethylene outer coat layer 18. Blade 10 preferably has a tip radius of about 200- 400 angstroms, measured by SEM before adding outer layer 18.

Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 114 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two, three, or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

Referring to FIG. 3, an alternative razor blade 22 includes substrate 12, hard carbon layer, 16, overcoat layer 24, and outer layer 18. The substrate, hard carbon layer, and outer layer generally are the same as in razor blade 10.

Overcoat layer 24 is discussed in U.S.S.N. 09/515,421, which is hereby incorporated by reference. The overcoat layer reduces the tip rounding of the hard coated edge and can facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 24 is preferably made of chromium containing material, e.g., chromium or chromium alloys, e.g. CrPt, that are compatible with polytetrafluoroethylene. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer. Chromium overcoat layer 24 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased



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negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200- 400 angstroms, measured by SEM after application of overcoat layer 24 and before adding outer layer 20.

Hard carbon layer 16, which is doped with chromium, adheres to substrate 12 even though the hard carbon layer is deposited directly on the substrate, without an interlayer. It is believed that the presence of the chromium dopant aids in the adhesion between the hard carbon layer and the cutting edge.

Other embodiments are within the claims. For example, the razor blade optionally may include neither an interlayer 14 nor an overcoat layer 24. In addition, titanium, niobium, tungsten, molybdenum, or silicon may be used in place of, or in addition to chromium, as the dopant in the hard carbon material.

Moreover, the razor blade may include two or more hard carbon layers. Each layer can include a different quantity of dopant and one or more layers may include no dopant. The hard carbon layers may include the same or different carbon-containing material.

For example, a hard carbon-containing layer may include a variable quantity of dopant. For example, the inner surface of the hard carbon layer may include 1 atomic percent dopant, and that quantity may increase among a gradient, with the outer surface of the hard carbon layer including 5 or 10 atomic percent of the dopant.

In addition, a hard carbon-containing layer may include two or more dopants selected, for example, from those mentioned previously.

Other embodiments are within the claims.

**WHAT IS CLAIMED IS:**

1. A razor blade, comprising
   a substrate with a cutting edge defined by a sharpened tip and adjacent facets;
   a coating of a carbon-containing material, doped with chromium, on the cutting edge; and
   a coating of polytetrafluoroethylene on the coating of a carbon-containing material;
   wherein there is no overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.
2. A razor blade, comprising
   a substrate with a cutting edge defined by a sharpened tip and adjacent facets;
   a coating of a carbon-containing material, doped with chromium, on the cutting edge; and
   a coating of polytetrafluoroethylene on the coating of a carbon-containing material;
   wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.
3. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material includes from 0.1 to 10 atomic percent chromium.
4. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material includes from 1 to 5 atomic percent chromium.
5. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material is diamond-like carbon.
6. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material is selected from the group consisting of diamond and amphorous diamond.
7. The razor blade of claim 1, further comprising an interlayer between the coating of a carbon-containing material and the cutting edge.
8. The razor blade of claim 7, wherein the interlayer comprises niobium.
9. The razor blade of claim 2, further comprising an overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.
10. The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. The razor blade of claims 1 or 2, wherein the coating of a carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. A shaving razor comprising

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the a coating of a carbon-containing material;

wherein there is no overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.

13. A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14. A method of making a razor blade comprising

coating a substrate having a cutting edge defined by a sharpened tip and adjacent facets with a carbon-containing material doped with chromium; and

coating the coating of carbon-containing material with polytetrafluoroethylene by contacting the coating of a carbon-containing material directly with an aqueous dispersion including polytetrafluoroethylene.

15. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets; and

a coating of diamond-like carbon on the cutting edge, the coating including from 0.1 to 10 atomic percent of a dopant.



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16. The razor blade of claim 15, wherein the coating includes from 1 to 5 atomic percent of a dopant.
17. The razor blade of claim 15, wherein the dopant is selected from the group consisting of titanium, niobium, tungsten, molybdenum, and silicon.
18. The razor blade of claim 17, wherein the dopant is selected from the group consisting of niobium, molybdenum, and silicon.
19. The razor blade of claim 17, wherein the dopant is chromium.
20. The razor blade of claim 15, further comprising an interlayer between the coating of diamond-like carbon and the cutting edge.
21. The razor blade of claim 15, further comprising a coating of polytetrafluoroethylene on the coating of diamond-like carbon.



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## ABSTRACT

A razor blade includes a substrate with a cutting edge and a coating of a carbon-containing material doped, for example, with chromium.

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Docket No. 00216-607001

# COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name;

I believe I am the original, first, and sole inventor (if only one name is listed below), or an original, first, and joint inventor (if plural names are listed below), of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**Razor Blade**

the specification of which

**X** is attached hereto.
__ was filed on as Application Serial No.
__ was filed as PCT International Application No. __________ on ___________

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which I know is material to patentability as defined in 37 C.F.R. §1.56.

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and to file and prosecute national, international, and regional applications which claim priority from this application:

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PACE-037299

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

| | |
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| | |
|---|---|
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| Citizenship: U.S.A. | Date: 2/20/03 |
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| Residence Address: | 101 Hanson Road<br>Newton, Massachusetts 02459 |
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| Inventor's signature: | Andrew Zhuk |
| Citizenship: Russia | Date: 2/20/03 |
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| Residence Address: | 117 Central Street, Apt. F-11<br>Acton, MA 01720 |



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PATENT APPLICATION SERIAL NO. ____________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

03/10/2003 SDIRETA1 00000020 10379264

| | |
|---|---|
| 01 FC:1001 | 750.00 OP |
| 02 FC:1202 | 108.00 OP |
| 03 FC:1201 | 252.00 OP |
| 04 FC:1203 | 280.00 OP |

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 489-267/69033

PACE-037302

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**PATENT APPLICATION FEE DETERMINATION RECORD**
Effective January 1, 2003

Application or Docket Number: 10,379264

## CLAIMS AS FILED - PART I

| | (Column 1) | (Column 2) |
|---|---|---|
| TOTAL CLAIMS | 21 | |
| FOR | NUMBER FILED | NUMBER EXTRA |
| TOTAL CHARGEABLE CLAIMS | 26 minus 20= | * 6 |
| INDEPENDENT CLAIMS | 6 minus 3 = | * 3 |
| MULTIPLE DEPENDENT CLAIM PRESENT | | ☐ |

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

| SMALL ENTITY RATE | FEE | | OTHER THAN SMALL ENTITY RATE | FEE |
|---|---|---|---|---|
| BASIC FEE | $375 | OR | BASIC FEE | $750 |
| X$ 9= | | OR | X$18= | 108 |
| X42= | | OR | X84= | 252 |
| +140= | | OR | +280= | 280 |
| TOTAL | | OR | TOTAL | 139[illegible] |

* If the difference in column 1 is less than zero, enter "0" in column 2

## CLAIMS AS AMENDED - PART II

### AMENDMENT A

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * | Minus | ** | = |
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| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ |

| SMALL ENTITY RATE | ADDITIONAL FEE | | OTHER THAN SMALL ENTITY RATE | ADDITIONAL FEE |
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| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
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| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT B

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
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| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
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| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT C

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
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| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
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| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

| CLAIMS ONLY | SERIAL NO. | FILING DATE |
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| | APPLICANT(S) | |

CLAIMS

| | AS FILED | | AFTER 1ST AMENDMENT | | AFTER 2ND AMENDMENT | | | | | | | | |
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| TOTAL IND. | 6 | | | | | | TOTAL IND. | | | | | | |
| TOTAL DEP. | 20 | | | | | | TOTAL DEP. | | | | | | |
| TOTAL CLAIMS | 26 | | | | | | TOTAL CLAIMS | | | | | | |

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PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 00216-607001 / Case 8104

3724

#2 11/5/03

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner :

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## INFORMATION DISCLOSURE STATEMENT

Applicants submit the references listed on the attached form PTO-1449.

One or more of applicants became aware of a razor cartridge Kai K-3$^{type}$ SR (Item BD) on the enclosed PTO Form 1449), that apparently was introduced in Japan around June, 2001. Samples of the Kai K-3$^{type}$ SR were obtained, brought into the United States, and analyzed in July-September, 2001. A copy of portions of an analysis of the Kai K-3$^{type}$ SR is enclosed as Exhibit A. The blade in the Kai K-3$^{type}$ SR does not appear to include an overlayer between the carbon layer and the telomer layer. For purposes of prosecution, it should be assumed that Kai K-3$^{type}$ SR has an effective prior art date of June 1, 2001, although applicants reserve the right to revisit this issue.

This statement is being filed before the receipt of a first Office action on the merits. Please apply any charges or credits to Deposit Account No. 06-1050.

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

October 28, 2003
Date of Deposit

Sherry L. Hunt
Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

PACE-037305

Respectfully submitted,

Date: October 28, 2003

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| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR 1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

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| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
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| | Filing Date March 4, 2003 | Group Art Unit 3724 |

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Substitute Disclosure Form (PTO-1449)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 884 142 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.12.1998 Bulletin 1998/51

(51) Int. Cl.[6]: B26B 21/60, B26B 21/54

(21) Application number: 98304533.7

(22) Date of filing: 09.06.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 10.06.1997 US 872443

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# (54) Improved blade edge

(57) A blade edge with increased durability and a reduced cut force and a method for manufacturing the same. The blade edge is thickened by depositing a coating or grinding. A thin film having a low coefficient of friction, such as amorphous diamond, is then applied to the edge. An additional layer of a lubricious polymer may then be applied. The resulting blade edge has a significantly reduced cut force over existing razor blades and also has greatly increased durability.

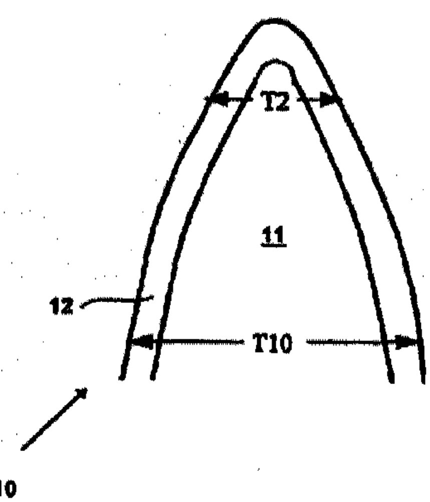


FIGURE 3

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**Description**

This invention relates to the forming and coating of blade edges to modify the cutting performance of the blade edge.

Razor blade manufacturers have over the years attempted various means of improving shave performance. The primary goal of the manufacturers has been to improve shave performance and comfort by reducing the required cut force and increasing the life of the blade edge. Generally, efforts at improving shave performance and reducing cut force have focused on providing edges with thinner, and theoretically sharper, edge profiles than prevailing blades. Since the thinner edges are weaker than their thicker counterparts, there have been efforts to simultaneously increase the strength of the edge. With regard to cut force, one means of reducing cut force is to modify the geometry of the razor blade edge. It has been found that reducing the width of the blade edge for some distance back from the tip will improve shave performance by cut force reduction. However, reduction in the edge width also weakens the edge and leads to more rapid deterioration due to mechanical deformation during cutting.

A typical razor blade edge has a wedge shape with a preferred included angle of approximately 20 degrees. This wedge may be further characterized by its tip radius, which is the radius of curvature of the ultimate cutting tip, and the thickness of the edge for a distance back from the ultimate tip. Typically, the tip radius is specified as being less than 500Å. The edge thickness is a function of distance from the ultimate edge. For example T2 and T10 may be defined as the width of the edge 2 microns and 10 microns back from the ultimate edge respectively. Typical razor blades have T2 values in the range of from 0.85 - 1.1μ and T10 values in the range of 3.3-4.0μ. Standard mechanical grinding and honing operations give the edge a bit of a convex shape which has been described as a "gothic arch" shape. Most razor blades have a thin layer of chromium on the cutting edge to increase the blade's corrosion resistance and to provide a good base for the application of a lubricating polymer such as polytetrafluoroethylene (PTFE). PTFE has an extremely low coefficient of friction and its use has become virtually universal in the razor blade industry. PTFE (an example of which is sold by duPont under the name KRYTOX 1000) is deposited on the blade edge as a fine powder which is heated above the melt point so that it flows and bonds to the blade edge. The lubricating polymer reduces the force required for the edge to cut through hair. Standard felt cutting tests demonstrate the large reduction in cut force for a PTFE coated edge compared to an uncoated chromium edge.

While the addition of a polymer to the blade edge reduces the cut force, a close look at the ultimate edge of the blade reveals that the ultimate tip is not fully covered by PTFE. Scanning electron microscope (SEM) micrographs show that the molten polymer has a tendency to pull back slightly from the edge. Consequently, polymer coated razor blades contain an uncoated region extending up to a few microns back from the tip of the blade. Therefore, the ultimate tip and cutting point does not benefit from the lubricating effect of the PTFE. It is an object of this invention to improve the lubrication of this small but critical area. It is a further object of this invention to improve the strength of the ultimate tip of the razor blade.

Various means to strengthen the edge, from using harder substrates for blades to the use of hard coatings to strengthen the edge, have been proposed. An example of a substrate that is inherently stronger than the presently used grade of stainless steel is described in U.S. patent 5,121,660 issued to Kramer. Kramer discloses a blade made of a polycrystalline ceramic material which is significantly harder than steel. However, this material is difficult to process and has not yet found commercial application for razor blades.

Hard coatings have been described numerous times as a means of increasing edge strength. For example, U. S. patent 4,933,058 issued to Bache, *et al.* describes the use of ion bombardment during hard coating deposition to achieve a prescribed tip shape. This tip is narrower than standard blades, but retains its strength due to the presence of a thick hard coating on the tip. U.S. patent 5,295,305, issued to Hahn, *et al* discloses the use of a diamond-like carbon (DLC) coating over various adhesion interlayers. The DLC coating is said to provide strength and high quality shaving performance. U.S. patents 5,142,785, issued to Grewal and 5,232,568, issued to Parent, *et al* both describe the use of DLC coatings over a molybdenum adhesion layer. Other patents have similarly disclosed a variety of ceramic coatings applied to strengthen the blade edge.

The modification of edge shape to provide a suitable substrate for hard coatings is disclosed in U.S. patent 5,032,243, issued to Bache, *et al* This patent discloses a method for modifying edge shape through ion beam bombardment. The ion beam removes material from both sides of the facet thus reducing its width. The ion beam method is proposed due to the difficulty in obtaining such blade profiles using mechanical grinding means. However, the ion beam method has its own difficulties and such an arrangement remains to be commercialized.

A somewhat different means of increasing blade life is disclosed in U.S. patent 5,468,774, issued to Janowski. This patent discloses the use of a diamond or DLC coating to reduce shaving degradation due to possible loss of the lubricating polymer during shaving. It is claimed that the PTFE is gradually removed from the edge and that the presence of a low friction coating will minimize the effect of the PTFE removal.

As can be seen, extensive effort has gone into producing thinner and stronger blade edges that minimize cut force while providing normal or extended life. Most



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of thes methods employ sophisticated means of shaping the blad edge followed by a thick coating of a bard material to strengthen the edge. These methods are difficult to implement and it would be advantageous to produce a blade that has the benefits of a thinner blade edge, i.e. low cut force, but without the attendant strength and production difficulties.

According to a first aspect of the invention there is provided a razor blade as set out in Claim 1.

According to a second aspect of the invention there is provided a razor blade as set out in Claim 14.

According to third and fourth aspects of the invention there are provided methods as set out in Claims 24 and 26.

Preferred features of the invention are set out in the dependent claims.

Consequently, it is an advantage of the present invention to provide such a razor blade and a means for production that avoids much of the difficulty associated with prior designs. Such a blade would advantageously have enhanced strength and durability and exhibit reduced cut forces compared to standard razor blades.

Preferred embodiments of the invention are directed to a blade edge with improved shave performance and a method of manufacturing such blades. To achieve the desired result the tip thickness, tip radius and cut force are increased, either by application of a first, non-polymeric coating or by some other means, and then the blade is coated with a second non-polymeric adherent coating having a very low coefficient of friction. Suitable materials for the second coating include the class of carbon films which include diamond, amorphous diamond, and diamond like carbon (DLC). Another material with a suitably low coefficient of friction is Molybdenum disulfide. The thickness of the coating need only be such that a continuous film, typically less than 500Å, is formed over the blade edge up to and including the ultimate tip. The aspect ratio of this film is approximately 1: 1; there is no need for the high aspect ratios claimed in previous disclosures. The blade is then coated with a lubricating polymer, such as PTFE, as is standard practice in the industry. The resulting blades cut with a significantly lower cut force than comparable blades without the low coefficient of friction film. The blade performs as if the edge were sharper and thinner while retaining the original edge geometry. Because the edge is of at least standard thickness it retains the hardness and durability of a regular edge.

A preferred embodiment of the invention emphasizes edge durability. In this case the edge is made thicker than usual via coating or grinding. Normally the thickening would have the effect of increasing the cut force and compromising shave performance. However, the addition of the coating of this invention reduces the cut force to a nominal level thus restoring shave comfort. Such coated blades last significantly longer and provide better shave performance than their uncoated counterparts by virtue of their thicker and stronger edge.

There now follows a description of preferred embodiments of the invention, by way of non-limiting example, with reference being made to the accompanying drawings in which:

Figure 1 is a chart illustrating the indent depths of blade edges having different coatings. A smaller indent signifies a stronger edge;

Figure 2 is a chart illustrating the effect of the coating of this invention on average cut force for 20 cuts; and

Figure 3 is a schematic representation of a razor blade according to the invention.

Reference will now be made in detail to the presently preferred embodiments of the invention.

The blade edge of the present invention comprises a razor blade having an increased tip thickness and tip radius, a reduced cutting force and a longer usable life. In order to provide these desirable properties, a substrate is provided in which the portion which is to be the cutting edge is prepared with a profile either nominal to or thicker than that of prevailing blades, resulting in increased tip thickness, tip radius, cut force and coefficient of friction. The increased thickness may be achieved in various manners, but a preferred method for achieving this shape is by appropriately grinding or stropping the edge. A further preferred method of producing this shape is by depositing an inner coating of suitable thickness onto the edge of the blade. This coating may consist of virtually any compatible material including oxides, carbides, nitrides, borides, metals and any combinations thereof, preferred materials include ceramics, chromium, chromium/platinum, and chrome nitride. The primary criteria for this coating are that it adheres to the steel substrate and that the coating of this invention adheres to it. In the preferred embodiment a coating of up to 1500 angstroms of chromium is applied to the edge of a ground blade. The actual thickness of the coating may vary depending on a number of variables, including the starting edge shape, and a thicker or thinner coating may be used as desired. The result of the initial thickening step is a blade edge which has increased tip thickness, increased strength, increased tip radius, is less sharp than before and exhibits a correspondingly higher cut force. For example, such a thickened blade edge would be less desirable for cutting hair in that it would tend to "pull" the hair and thus prove uncomfortable during wet shaving.

Once a suitable blade edge is obtained, the edge is coated with an outer coating of a thin film of a non-polymeric material which has a very low coefficient of friction. The outer coating may be deposited by ion beam sputtering, magnetron sputtering, laser beam ablation, vacuum arc deposition, or any other suitable process. The thickness of this non-polymeric coating is preferably less than about 1500 angstroms and an aspect ratio



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(tip thickness/flank thickness) of about 1:1 is preferably obtained. In an especially preferred embodiment, the thickness of the non-polymeric coating is in the rang of from 100 - 1000 angstroms. A preferred value for the low coefficient of friction is less than about 0.3 and preferably less than 0.2. Preferred materials having such a low coefficient for the thin film coating are amorphous diamond, diamond-like carbon (DLC), molybdenum disulfide, or any other similar material. The preferred thin film coating material is amorphous diamond. Amorphous diamond comprises a nonhydrogenated version of DLC with at least 40% sp3 carbon bonding, a hardness of at least 45 gigapascals and a modulus of at least 400 gigapascals. In contrast, standard DLC has a hardness of only about 30 gigapascals. The resultant blade edge has a further increased tip radius and tip thickness over the blade edge having no coating or the inner coating alone, and has a cut force which is significantly lower than that of the blade edge having the first coating alone. In an especially preferred embodiment, the blade edge may be further coated with a lubricious polymer to further reduce the cut force. Because this coating has been shown to pull back from the edge the presence of the hard, thin film of low coefficient of friction causes the blade to show a significant reduction in cut force over blades having only chromium or other conventional materials on the edge. This superiority of cut force is evident even over sharper blades using conventional coatings. In an especially preferred embodiment, the blade edge is first coated with a thin film having a low coefficient of friction, such as amorphous diamond, and then with a lubricious polymer such as low molecular weight PTFE or KRYTOX 1000 to provide a shave exhibiting minimal cut force. The resulting razor blade is especially advantageous for use with a wet shave razor, and one or more of such blades may be employed in a razor. The blades may be employed in a wet shave razor which is either disposable, i.e. the entire razor is discarded after a certain amount of usage, or permanent which requires disposal and replacement of only the razor cartridge, but not the handle, after a certain number of uses.

A variety of methods are available for depositing the coating of this invention. One method uses pulsed laser deposition to generate a plume of vaporized carbon ions from a solid carbon source. These ions can be directed to the edge of a blade where they will condense as a hard solid film with a suitable low coefficient of friction. Another method is the use of sputtering, either RF or DC, to provide a vapor of carbon atoms which similarly condense onto the blades forming carbon films. Typically, the sputtered films are not as hard as coatings prepared by other means but they may be used due to their low coefficient of friction. CVD methods can be utilized, using a gaseous hydrocarbon gas as the source, but these must be done under conditions where the blades do not exceed 350°C for periods of time as this will soften the blade steel. A preferred method of depositing the carbon films is by the cathodic arc method. Such a method is described fully in patent 5,458,754, assigned to Multi Arc Inc. in New Jersey and the disclosure of that patent is incorporated herein by reference. In this method carbon ions are produced with the arc vaporization of a solid graphite target. The patented method described produces amorphous diamond films with a very low coefficient of friction.

As illustrated in Figure 1, the blade edge which is coated with chromium has significantly increased strength over the uncoated blade edge. Specifically, an unused, standard blade edge will be indented to a depth of approximately 650 nanometers by a 4 gram load applied normal to the blade edge. Coating with 300 Å of chromium increases the edge strength as shown by a reduction in indent depth to about 610 nm, while 600 angstroms of chromium coating further reduces the indents to about 595 nm. A 600 angstrom chromium coating in combination with an amorphous diamond coating of 200-300 angstroms significantly reduces the indent range to approximately 540 nm, thus illustrating that the blade of the present invention is significantly stronger than a standard blade.

Figure 2 illustrates the cut force of a standard blade, a less sharp blade made according to this invention, and a similar less sharp blade including the amorphous diamond coating. All blades are coated per standard process with PTFE. The standard blade edge exhibits a cut force of 2.64 lb. The less sharp blade exhibits an average cut force of 2.96 lb. The addition of 250 angstroms of amorphous diamond to the less sharp blade results in a cut force of 2.46 lb, a significant reduction over the uncoated blade. Consequently, blades made according to this invention are exceedingly durable and will continue to exhibit advantages over conventional blades for hundreds of cuts.

Figure 3 shows a blade edge 10 according to the invention. Blade edge 10 includes a substrate 11 coated with a non-polymer inner coating (not shown separately in Figure 3). The material of the coating may be, for example, Chromium to a thickness of 1500 angstroms. The inner coating if applied on its own to the blade edge 10 would increase the tip radius and the cut force characteristic of the blade edge 10 to higher values than those of conventional blade edges.

Blade edge 10 also includes an outer coating 12 of a further material having a low coefficient of friction relative to eg. human or animal skin. The outer coating 12 increases the tip radius and tip thickness still further compared with a conventional blade, yet provides for a lower cut force.

The outer coating 12 may be of a material as specified herein.

The blade edge 10 is preferably manufactured in accordance with the method of the invention.

While there have been described what are presently believed to be the preferred embodiments of the present invention, those skilled in the art will realize that



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various changes and modifications may be made to the invention without departing from the spirit of the invention, and it is intended to claim all such changes and modifications as fall within the scope of the invention.

**Claims**

1. A razor blade comprising a substrate having a cutting edge which has a first tip radius and first tip thickness and an initial cut force, coated with a non-polymer inner coating of a first material sufficient to increase the initial cut force and provide a second, increased tip radius, a second, increased tip thickness and increase the strength of the cutting edge, and a non-polymer outer coating of a second material having a low coefficient of friction, wherein the second coating provides a third tip radius which is greater than the second tip radius, a third tip thickness which is greater than the second tip thickness and a cut force which is less than the initial cut force, and wherein the first and second materials are different from each other.

2. A razor blade according to claim 1, wherein the first material is selected from the group consisting of oxides, carbides, nitrides, borides, metals, chromium, ceramics, chromiun/platinum, chrome nitride and combinations of this group.

3. A razor blade according to claim 2, wherein the first material is chromium.

4. A razor blade according to claim 2 or claim 3, wherein the inner coating is up to 1500 angstroms thick.

5. A razor blade according to any preceding claim, wherein the second material comprises a non-polymer material sufficient to reduce the coefficient of friction of the substrate.

6. A razor blade according to claim 5, wherein the second material has a coefficient of friction of less than about 0.3.

7. A razor blade according to any preceding claim, wherein the second material is selected from the group consisting of amorphous diamond, DLC (diamondlike carbon), and molybdenum disulfide.

8. A razor blade according to claim 7, wherein the second material is amorphous diamond.

9. A razor blade according to claim 8, wherein the amorphous diamond coating is in the range of about 100 to about 1000 angstroms thick.

10. A razor blade according to any preceding claim further comprising a third coating consisting of a lubricious polymer.

11. A razor blade according to claim 10, wherein the lubricious polymer is polytetraflouroethylene or KRYTOX.

12. A razor blade according to claim 9 or any claim dependent therefrom, wherein the aspect ratio is about 1:1.

13. A wet shave razor comprising at least one blade according to any preceding claim.

14. A razor blade comprising a substrate having a cutting edge that has been increased in width and tip radius sufficient to increase the cutting force and a non-polymer coating sufficient to further increase the tip width and tip radius and to reduce the cut force of the cutting edge.

15. A razor blade according to claim 14, wherein the cutting edge is increased in tip radius and width via grinding or stropping.

16. A razor blade according to claim 14 or claim 15, wherein the coating comprises a non-polymer material having a coefficient of friction of less than about 0.3.

17. A razor blade according to any of claims 14 to 16, wherein the coating is selected from the group consisting of amorphous diamond, diamondlike carbon, and molybdenum disulfide.

18. A razor blade according to claim 17, wherein the coating is amorphous diamond.

19. A razor blade according to claim 18, wherein the amorphous diamond coating is in the range of about 100 to 1000 angstroms thick.

20. A razor blade according to any of claims 14 to 19 further comprising a second coating consisting of a lubricious polymer.

21. A razor blade according to claim 20, wherein the coating is polytetraflouroethylene or KRYTOX.

22. A razor blade according to claim 19, wherein the aspect ratio of the amorphous diamond coating is about 1:1.

23. A wet shave razor comprising at least one blade according to any of claims 14 to 22.

24. A method for manufacturing a razor blade having a cutting edge, comprising the steps of



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a) providing a substrate;

b) coating the cutting edge of the razor blade with a first, non-polymer coating which is sufficient to increase th tip thickness, tip radius and cut force of the cutting edge, and

c) coating the cutting edge of the razor blade with a second, non-polymer coating which is sufficient to increase the tip radius and tip thickness of the cutting edge and to reduce the coefficient of friction of the cutting edge.

25. A method for manufacturing a razor blade according to claim 24, comprising the additional step of coating the cutting edge of the razor blade with a lubricious polymer.

26. A method for manufacturing a razor blade having a cutting edge, comprising the steps of

a) providing a substrate;

b) thickening the cutting edge of the razor blade sufficiently so as to increase the cut force of the blade,

c) coating the cutting edge of the razor blade with a non-polymer coating having a low coefficient of friction sufficient to increase the tip thickness and tip radius of the cutting edge and to reduce the cut force of the edge.

27. A method for manufacturing a razor blade according to claim 26, wherein the thickening step is performed via grinding or stropping.

28. A method for manufacturing a razor blade according to claim 26 or claim 27, comprising the additional step of coating the cutting edge of the razor blade with a lubricious polymer.



PACE-037314

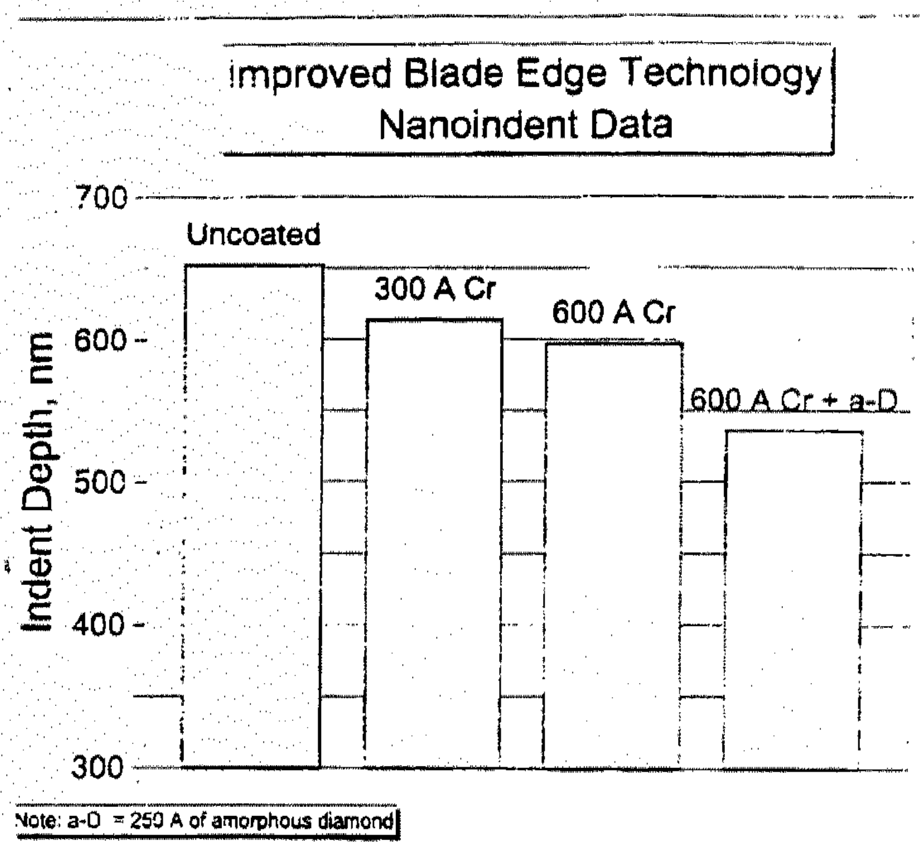


Figure 1



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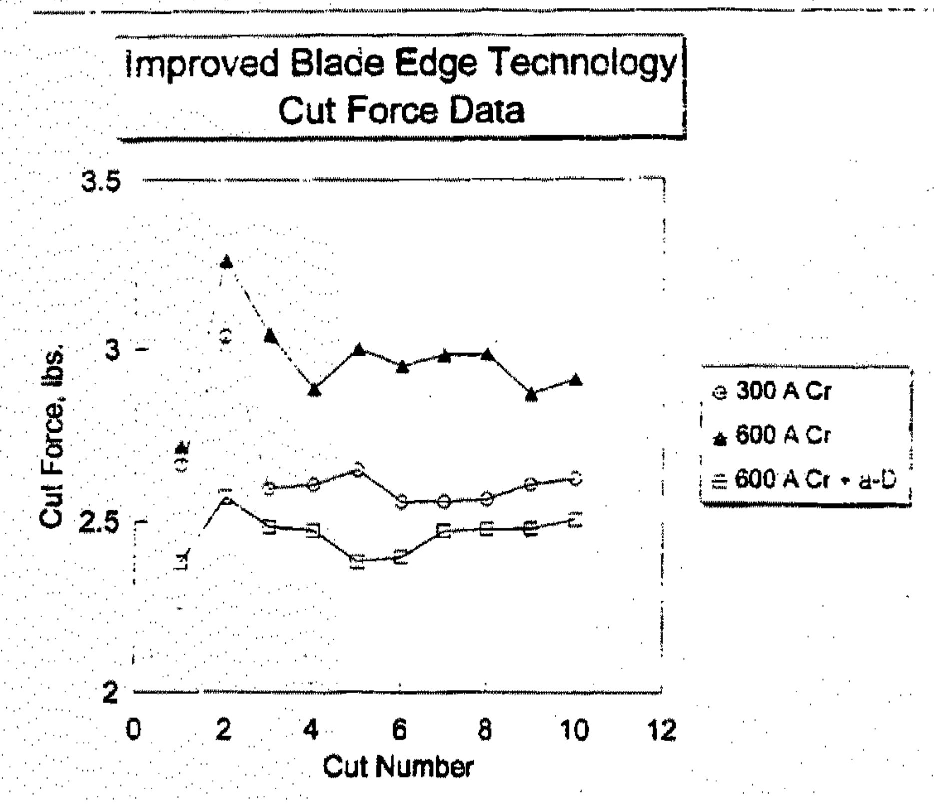


Figure 2



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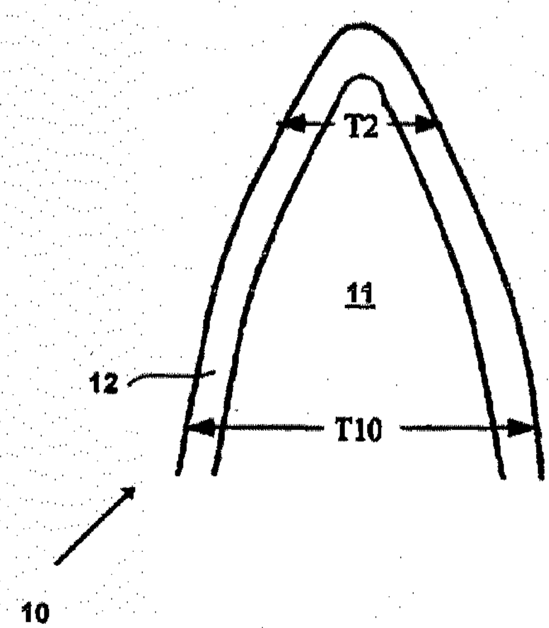


FIGURE 3



PACE-037317

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 98 30 4533

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X | WO 84 02104 A (GLASSON EDWIN LLOYD PERSONAL R ;KOZLOWSKA JADWIGA PERSONAL REP (GB) 7 June 1984<br>* page 4, line 24 - page 5, line 13 *<br>* page 6, line 13 - line 29; figures 10,10A * | 14,15, 20,26-28 | B26B21/60<br>B26B21/54 |
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| A | US 5 232 568 A (PARENT C ROBERT ET AL)<br>3 August 1993<br>* the whole document * | 1,14,24, 26 | TECHNICAL FIELDS SEARCHED (Int.Cl.6)<br>B26B |
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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 15 September 1998 | Herygers, J |

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)



PACE-037318

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 591 339 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
12.08.1998 Bulletin 1998/33

(21) Application number: 92913506.9

(22) Date of filing: 11.06.1992

(51) Int. Cl.[6]: B26B 21/54, C23C 14/32

(86) International application number:
PCT/US92/04932

(87) International publication number:
WO 93/00204 (07.01.1993 Gazette 1993/02)

# (54) RAZOR BLADE AND PROCESS FOR FORMING A RAZOR BLADE

RASIERKLINGE UND VERFAHREN ZUR HERSTELLUNG EINER RASIERKLINGE

LAME DE RASOIR ET PROCEDE DE FABRICATION D'UN LAME DE RASOIR

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(30) Priority: 24.06.1991 US 719793
15.11.1991 US 792427

(43) Date of publication of application:
13.04.1994 Bulletin 1994/15

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EP 0 591 339 B1

Printed by Xerox (UK) Business Services
2.16.3/3.4

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## Description

This invention relates to improved razors and razor blades and to processes for producing razor blades or similar cutting tools with sharp and durable cutting edges. A razor blad typically is formed of a suitable substrate material such as metal or ceramic and an edge is formed with wedge-shape configuration with an ultimate edge or tip that has a radius of less than about 1,000 angstroms. During use, a razor blade is held in the razor at an angle of approximately 25°, and with the wedge-shaped edge in contact with the skin, it is moved over the face so that when the edge encounters a beard hair, it enters and severs it by progressive penetration, aided by a wedging action. It is believed that the cut portion of the hair (which on average is about 100 micrometers in diameter) remains pressed in contact with the blade facets remote from the facial skin surface for a penetration up to only about half the hair diameter. Beyond this, the hair can bend and contract away from the blade to relieve the wedging forces. The resistance to penetration through reaction between hair and blade facets therefore occurs only over about the first sixty micrometers of the blade tip back from the edge and the geometry of the blade tip in this region is regarded as being the most important from the cutting point of view.

It is believed that a reduction in the included angle of the facets would correspondingly reduce the resistance to continued penetration of the blade tip into the hair.

U.S. Patent No. 4,720,918 discloses a razor blade having a steel substrate that has been mechanically abraded to form a wedge-shaped sharpened edge having desirable cutting dimensions.

It has been found, however, when the included angle is reduced too much, the strength of the blade tip is inadequate to withstand the resultant bending forces on the edge during the cutting process and the tip deforms plastically (or fractures in a brittle fashion, dependent on the mechanical properties of the material from which it is made) and so sustains permanent damage, which impairs its subsequent cutting performance, i.e. the edge becomes "blunt" or "dull". As shaving action is severe and blade edge damage frequently results, and to enhance shavability, the use of one or more layers of supplemental coating material has been proposed for shave facilitation, and/or to increase the hardness, strength and/or corrosion resistance of the shaving edge.

U.S. Patent No. 3,761,372 discloses a process for depositing a strengthening layer of metal or alloy material such as chromium or chrome-platinum upon a sharpened edge of a razor blade.

U.S. Patent No. 4,933,058, upon which the preambles of claims 1 and 5 are based, discloses a process for forming hard coatings on razor blades.

A number of coating materials such as polymeric materials, and diamond and diamond-like carbon (DLC) materials hav been proposed besides metals and alloys. Diamond and diamond-like carbon (DLC) materials may be characterized as having substantial $sp^3$ carbon bonding; a mass density greater than 1.5 grams/cm$^3$; and a Raman peak at about 1331 cm$^{-1}$ (diamond) or about 1550 cm$^{-1}$ (DLC). Each such layer or layers of supplemental material desirably provides characteristics such as improve shavability, improved hardness, edge strength and/or corrosion resistance whole not adversely affecting the geometry and cutting effectiveness of the shaving edge.

German Patent DE 3,047,888 discloses a coated steel substrate having an interlayer of material.

According to a first aspect of the invention, there is provided a process for forming a razor blade including mechanically abrading a substrate to form a wedge-shaped sharpened edge thereon having a tip with a radius of less than twelve hundred angstroms, and forming a layer of diamond or diamond-like carbon material on said sharpened edge of said substrate by positioning said substrate and a solid target member in a chamber, and sputtering said solid target member to generate carbon atoms for forming said layer of diamond or diamond-like carbon material on said sharpened edge of said substrate from said carbon atoms while applying an RF bias to said substrate, said layer of diamond or diamond-like carbon material forming an ultimate tip having an aspect ratio of 1:1 - 3:1, said wedge-shaped sharpened edge being formed with a sharpened tip having an included angle of less than 17° at a distance of 40µm (micrometers) from a tip of said sharpened edge, said layer of diamond or diamond-like carbon material having a thickness of at least 1200 Å (angstroms) from the sharpened tip of the substrate to a distance of forty micrometers from the sharpened tip, characterized in that said ultimate tip has a radius of less than 400 Å (angstroms) and is defined by two facets each having a length of at least about 0.1 micrometer and defining an included angle of at least sixty degrees.

According to a second aspect of the invention, there is provided a razor blade including a substrate having a wedge-shaped sharpened edge formed thereon, said wedge-shaped sharpened edge including a sharpened tip and a layer of diamond or diamond-like carbon material formed on said sharpened edge of said substrate, said layer of diamond or diamond-like carbon material having a thickness of at least twelve hundred angstroms from the sharpened tip to a distance of forty micrometers from the sharpened tip, said layer of diamond or diamond-like carbon material includes an ultimate tip having an aspect ratio ranging from about 1:1-3:1, said sharpened tip having an included angle of less than seventeen degrees at a distance of forty micrometers from the sharpened tip, characterized in that said sharpened tip has an L5 wet wool felt cutter force of less than 0.8 kilogram, dry wool felt (ten cuts) edge damage of less than fifty small edge damage regions and no



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damage regions of larger dimension or depth, and a radius at the ultimate tip of less than 400 Å (angstroms), said ultimate tip being defined by facets having a length of at least about 0.1 micrometer and an included angle of at least 60°.

The process may include the step of depositing a layer of material on the wedge-shaped sharpened edge to a thickness of about 300 Å (angstroms) or less prior to depositing the layer of diamond or diamond-like carbon material.

The process may include the step of depositing an adherent polymer coating on the layer of diamond or diamond-like carbon material.

According to another embodiment of the invention, there is provided a shaving unit including a support structure defining spaced-apart, skin-engaging surfaces, one or more razor blade structures mounted to said support structure and being disposed between said skin-engaging surfaces, each said one or more razor blade structure including a razor blade of the type recited above.

The shaving unit may be of the disposable cartridge type adapted for coupling to and uncoupling from a razor handle or may be integral with a handle so that the complete razor is discarded as a unit when the blade or blades become dull. The front and rear skin-engaging surfaces cooperate with the blade edge (or edges) to define the shaving geometry. Particularly preferred shaving units are of the types shown in U.S. Patent 4,586,255.

Other features and advantages of the invention will be seen as the following description of particular embodiments progresses, in conjunction with the drawings, in which:

Fig. 1 is a perspective view of a shaving unit in accordance with the invention;
Fig. 2 is a perspective view of another shaving unit in accordance with the invention;
Fig. 3 is a diagrammatic view illustrating one example of razor blade edge geometry in accordance with the invention;
Fig. 4 is a diagrammatic view of apparatus for the practice of the invention; and
Figs. 5 and 6 are Raman spectra of DLC material deposited with the apparatus of Fig. 4.

## Description of Particular Embodiments

With reference to Fig. 1, shaving unit 10 includes structure for attachment to a razor handle, and a platform member 12 molded of high-impact polystyrene that includes structure defining forward, transversely-extending skin engaging surface 14. Mounted on platform member 12 are leading blade 16 having sharpened edge 18 and following blade 20 having sharpened edge 22. Cap member 24 of molded high-impact polystyrene has structure defining skin-engaging surface 26 that is disposed rearwardly of blade edge 22, and affixed to cap member 24 is shaving aid composite 28.

The shaving unit 30 shown in Fig. 2 is of the type shown in Jacobson U.S. Patent 4,586,255 and includes molded body 32 with front portion 34 and rear portion 36. Resiliently secured in body 32 are guard member 38, leading blade unit 40 and trailing blade unit 42. Each blade unit 40, 42 includes a blade member 44 that has a sharpened edge 46. A shaving aid composite 48 is frictionally secured in a recess in rear portion 36.

A diagrammatic view of the edge region of the blades 16, 20 and 44 is shown in Fig. 3. The blade includes stainless steel body portion 50 with a wedge-shaped sharpened edge formed in a sequence of edge forming honing operations that forms a tip portion 52 that has a radius typically less than 500 angstroms with facets 54 and 56 that diverge at an angle of about 13°. Deposited on tip 52 and facets 54, 56 is interlayer 58 of molybdenum that has a thickness of about 300 angstroms. Deposited on molybdenum interlayer 58 is outer layer 60 of diamond-like carbon (DLC) that has a thickness of about 2,000 angstroms, with facets 62, 64 that have lengths of about one-quarter micrometer each and define an included angle of about 80°, facets 62, 64 merging with main facet surfaces 66, 68 that are disposed at an included angle of about 13° and an aspect ratio (the ratio of the distance (a) from DLC tip 70 to stainless steel tip 52 and the width (b) of the DLC coating 60 at tip 52) of about 1.7. Deposited on layer 60 is an adherent telomer layer 72 that has a substantial as deposited thickness but is reduced to monolayer thickness during initial shaving.

Apparatus for processing blades of the type shown in Fig. 3 is diagrammatically illustrated in Fig. 4. That apparatus includes a DC planar magnetron sputtering system manufactured by Vac Tec Systems of Boulder, Colorado that has stainless steel chamber 74 with wall structure 80, door 82 and base structure 84 in which is formed port 86 coupled to a suitable vacuum system (not shown). Mounted in chamber 74 is carousel support 88 with upstanding support member 90 on which is disposed a stack of razor blades 92 with their sharpened edges 94 in alignment and facing outwardly from support 90. Also disposed in chamber 74 are support structure 76 for target member 96 of molybdenum (99.99% pure) and support structure 78 for target member 98 of graphite (99.999% pure). Targets 96 and 98 are vertically disposed plates, each about twelve centimeters wide and about thirty-seven centimeters long. Support structures 76, 78 and 88 are electrically isolated from chamber 74 and electrical connections are provided to connect blade stack 92 to RF power supply 100 through switch 102 and to DC power supply 104 through switch 106; and targets 96 and 98 are connected through switches 108, 110, respectively, to DC magnetron power supply 112. Shutter structures 114 and 116 are disposed adjacent targets 96, 98, respectively, for movement between an open position and a



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position obscuring its adjacent target.

Carousel 88 supports the blade stack 92 with the blade edges 94 spaced about seven centimeters from the opposed target plate 96, 98 and is rotatable about a vertical axis between a first position in which blade stack 92 is in opposed alignment with molybdenum target 96 (Fig. 4) and a second position in which blade stack 92 is in opposed alignment with graphite target 98.

In a particular processing sequence, a stack of blades 92 (thirty centimeters high) is secured on support 90 (together with three polished stainless steel blade bodies disposed parallel to the target); chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; switch 102 is then closed and the blades 92 are RF cleaned in an argon environment for three minutes at a pressure of ten millitorr, an argon flow of 200 sccm and a power of 1.5 kilowatts; the argon flow is then reduced to 150 sccm at a pressure of 4.5 millitorr in chamber 74; switch 106 is closed to apply a DC bias of -50 volts on blades 92; switch 108 is closed to sputter target 96 at one kilowatt power; and shutter 114 in front of molybdenum target 96 is opened; for twenty-eight seconds to deposit a molybdenum layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 is then closed, switches 106 and 108 are opened, and carousel 88 is rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 is reduced to two millitorr with an argon flow of 150 sccm; switch 110 is closed to sputter graphite target 98 at 500 watts; switch 102 is closed to apply a 13.56 MHz RF bias of one thousand watts (-440 volts DC self bias voltage) on blades 92, and concurrently shutter 116 is opened for twenty minutes to deposit a DLC layer 60 of about two thousand angstroms thickness on molybdenum layer 58. The DLC coating 60 had a radius at tip 70 of about 250 Angstroms that is defined by facets 62, 64 that have an included angle of about 80°, an aspect ratio of about 1.7:1, and a hardness (as measured on the planar surface of an adjacent stainless steel blade body with a Nanoindenter X instrument to a depth of five hundred angstroms) of about seventeen gigapascals (the stainless steel blade body having a hardness of about eight gigapascals). As illustrated in Fig. 5, Raman spectroscopy of the coating material 60 deposited in this process shows a broad Raman peak 120 at about 1400-1500 $cm^{-1}$ wave number, a spectrum typical of DLC structure.

A coating 72 of polytetrafluoroethylene telomer is then applied to the DLC-coated edges of the blades. The process involves heating the blades in a neutral atmosphere of argon and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. Coatings 58 and 60 were firmly adherent to the blade body 50 and provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.45 kilogram), and withstood repeated applications of wet wool felt cutter forces (the lowest cutter force of the 496-500 cuts being about 0.65 kilogram), indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50. Edge damage and delamination after ten cuts with dry wool felt as determined by microscopic assessment was substantially less than commercial chrome-platinum coated blades, there being less than four small edge damage regions (each such small damage region being of less than twenty micrometer dimension and less than ten micrometer depth) and no damage regions of larger dimension or depth. Resulting blade elements 44 were assembled in cartridge units 30 of the type shown in Fig. 2 and shaved with excellent shaving results.

In another particular processing sequence, a stack of blades 92 (thirty centimeters high) is secured on support 90 (together with three polished stainless steel blade bodies disposed parallel to the target); chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; switch 102 is then closed and the blades 92 are RF cleaned in an argon environment for two and a quarter minutes at a pressure of ten millitorr, an argon flow of 200 sccm and a power of 1.5 kilowatts; the argon flow is then reduced to 150 sccm at a pressure of six millitorr in chamber 74; switch 106 is closed to apply a DC bias of -50 volts on blades 92; shutter 114 in front of molybdenum target 96 is opened; and switch 108 is closed to sputter target 96 at one kilowatt power for thirty-two seconds to deposit a molybdenum layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 is then closed, switches 106 and 108 are opened, and carousel 88 is rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 is reduced to two millitorr with an argon flow of 150 sccm; switch 110 is closed to sputter graphite target 98 at 500 watts; switch 102 is closed to apply a 13.56 MHz RF bias of 320 watts (-220 volts DC self bias voltage) on blades 92, and concurrently shutter 116 is opened for seven minutes to deposit a DLC layer 60 of about 900 angstroms thickness on molybdenum layer 58. The DLC coating 60 had a tip radius of about 300 Angstroms, an aspect ratio of 1.6:1, and a hardness (as measured on the planar surface of an adjacent stainless steel blade body as measured with a Nanoindenter X instrument) of about thirteen gigapascals.

A coating 72 of polytetrafluoroethylene telomer is then applied to the DLC-coated edges of the blades in accordance with the teaching of U.S. Patent No. 3,518,110. The process involved heating the blades in a neutral atmosphere of argon and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. Coatings 58 and 60 were firmly adherent to the blade body 50, provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.6 kilogram), and withstood repeated applications of wet wool felt cutter



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forces (the lowest cutter force of the 496-500 cuts being about 0.76 kilogram), indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50. Edge damage and delamination after ten cuts with dry wool felt as determined by microscopic assessment was substantially less than commercial chrome-platinum coated blades, there being less than four small edge damage regions (each such small damage region being of less than twenty micrometer dimension and less than ten micrometer depth) and no damage regions of larger dimension or depth. Resulting blade elements 44 were assembled in cartridge units 30 of the type shown in Fig. 2 and shaved with excellent shaving results.

In another processing sequence, chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; switch 102 is then closed and the blades 92 are RF cleaned in an argon environment for two and a quarter minutes at a pressure of ten millitorr, an argon flow of 200 sccm and a power of 1.5 kilowatts; the argon flow is then reduced to 150 sccm at a pressure of six millitorr in chamber 74; switch 106 is closed to apply a DC bias of -50 volts on blades 92; shutter 114 in front of molybdenum target 96 is opened; and switch 108 is closed to sputter target 96 at one kilowatt power for thirty-two seconds to deposit a molybdenum layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 is then closed, switches 106 and 108 are opened, and carousel 88 is rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 is reduced to two millitorr with an argon flow of 150 sccm; switch 110 is closed to sputter graphite target 98 at 500 watts; switch 102 is closed to apply a 13.56 MHz RF bias of 320 watts (-220 volts DC self bias voltage) on blades 92, and concurrently shutter 116 is opened for five minutes to deposit a DLC layer 60 of about 600 angstroms thickness on molybdenum layer 58. The DLC coating 60 had a tip radius of about 400 Angstroms, an aspect ratio of 1.7:1, and a hardness (as measured on the planar surface of an adjacent stainless steel blade body as measured with a Nanoindenter X instrument) of about thirteen gigapascals. As illustrated in Fig. 6, Raman spectroscopy of the coating material 60 deposited in this process shows a broad Raman peak 122 at about 1543 $cm^{-1}$ wave number, a spectrum typical of DLC structure.

A telomer coating 72 was applied to the blade edges with a nitrogen atmosphere. The resulting coatings 58 and 60 were firmly adherent to the blade body 50, provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.6 kilogram), and withstood repeated applications of wet wool felt cutter forces (the lowest cutter force of the 496-500 cuts being about 0.76 kilogram), indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50. Edge damage and delamination after ten cuts with dry wool felt as determined by microscopic assessment was substantially less than commercial chrome-platinum coated blades, there being less than five small edge damage regions (each such small damage region being of less than twenty micrometer dimension and less than ten micrometer depth) and no damage regions of larger dimension or depth. Resulting blade elements 44 were assembled in cartridge units 30 of the type shown in Fig. 2 and shaved with excellent shaving results.

While particular embodiments of the invention has been shown and described, various modifications will be apparent to those skilled in the art, and therefore, it is not intended that the invention be limited to the disclosed embodiments, or to details thereof, and departures may be made therefrom within the scope of the invention as defined by the claims.

## Claims

1. A process for forming a razor blade (16, 20, 44) including mechanically abrading a substrate (50) to form a wedge-shaped sharpened edge thereon having a tip (52) with a radius of less than twelve hundred angstroms, and forming a layer of diamond or diamond-like carbon material (60) on said sharpened edge of said substrate by positioning said substrate and a solid target member (98) in a chamber (74), and sputtering said solid target member to generate carbon atoms for forming said layer of diamond or diamond-like carbon material (60) on said sharpened edge of said substrate from said carbon atoms while applying an RF bias to said substrate, said layer of diamond or diamond-like carbon material (60) forming an ultimate tip (70) having an aspect ratio of 1:1 - 3:1, said layer of diamond or diamond-like carbon material having a thickness of at least 1200 Å (angstroms) from the sharpened tip of the substrate to a distance of forty micrometers from the sharpened tip, said wedge-shaped sharpened edge being formed with a sharpened tip having an included angle of less than 17° at a distance of 40μm (micrometers) from a tip of said sharpened edge, characterized in that said ultimate tip (70) has a radius of less than 400 Å (angstroms) and is defined by two facets (62, 64) each having a length of at least about 0.1 micrometer and defining an included angle of at least sixty degrees.

2. A process for forming a razor blade according to claim 1, characterized in that said solid target member (98) is a highly pure graphite target, said sputtering step including aligning a shutter (116) between said highly pure graphite target (98) and said substrate in an inert gas environment, applying electrical energy to said highly pure graphite target and opening said shutter (116) for a predetermined period of time while applying said bias to said sub-



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strate to form said layer of diamond or diamond-like material.

3. A process for forming a razor blade according to any one of claims 1-2, characterized by the step of depositing an interlayer of molybdenum on said wedge-shaped sharpened edge to a thickness of 300 Å (angstroms) or less prior to depositing said layer of diamond or diamond-like carbon material, said step of depositing said interlayer of molybdenum including positioning a molybdenum target (96) in said chamber (74) and positioning a shutter (114) in alignment between said molybdenum target (96) and said substrate, applying electrical energy to said molybdenum target (96) and opening said shutter (114) for a predetermined period of time to deposit said interlayer of molybdenum.

4. A process for forming a razor blade according to any one of claims 1-3, further including the step of depositing an adherent polymer coating (72) on said layer of diamond or diamond-like carbon material (60).

5. A razor blade (16, 20, 44) including a substrate (50) having a wedge-shaped sharpened edge formed thereon, said wedge-shaped sharpened edge including a sharpened tip (52) and a layer of diamond or diamond-like carbon material (60) formed on said sharpened edge of said substrate, said layer of diamond or diamond-like carbon material (60) having a thickness of at least twelve hundred angstroms from the sharpened tip (52) to a distance of forty micrometers from the sharpened tip (52), said layer of diamond or diamond-like carbon material (60) includes an ultimate tip (70) having an aspect ratio ranging from about 1:1-3:1, said sharpened tip (52) having an included angle of less than seventeen degrees at a distance of forty micrometers from the sharpened tip (52), characterized in that said sharpened tip (52) has an L5 wet wool felt cutter force of less than 0.8 kilogram, dry wool felt (ten cuts) edge damage of less than fifty small edge damage regions and no damage regions of larger dimension or depth, and a radius at the ultimate tip of less than 400 Å (angstroms), said ultimate tip (70) being defined by facets (62, 64) having a length of at least about 0.1 micrometer and an included angle of at least 60°.

6. A razor blade according to claim 5, characterized by an interlayer of molybdenum (58) deposited on said wedge-shaped sharpened edge, said interlayer of molybdenum deposited to a thickness of 300 Å (angstroms) or less, said layer of diamond or diamond-like carbon material (60) being deposited on said molybdenum interlayer (58).

7. A razor blade according to any one of claims 5-6, further including a layer of adherent polymer (72) on said layer of diamond or diamond-like carbon material.

8. A shaving unit (10,30) including a support structure (12, 32) defining spaced-apart, skin-engaging surfaces (14, 26, 34, 36), one or more razor blade structures (40, 42) mounted to said support structure and being disposed between said skin-engaging surfaces, each said one or more razor blade structure (40, 42) including a razor blade (16, 20, 44) according to any one of claims 5-7.

**Patentansprüche**

1. Verfahren zum Herstellen einer Rasierklinge (16, 20, 44), einschließend mechanisches Abtragen eines Substrats (50), um eine keilförmig geschärfte Kante darauf zu erzeugen, die eine Spitze (52) mit einem Radius von Weniger als zwölf Hundertstel Angström aufweist, und Erzeugen einer Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) auf der geschärften Kante des Substrats durch Anordnen des Substrats und eines festen Targetteils (98) in einer Kammer (74) und Sputtern des festen Targetteils, um Kohlenstoffatome zur Bildung der Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) auf der geschärften Kante des Substrats aus den Kohlenstoffatomen zu erzeugen, während eine HF-Vorspannung an dem Substrat angelegt wird, wobei diese Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) eine äußerste Spitze (70) bildet, die ein Höhe/Breite-Verhältnis von 1:1 bis 3:1 aufweist, wobei die Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial eine Dicke von mindestens 1.200 Å (Angström) von der geschärften Spitze des Substrats bis zu einem Abstand von vierzig Mikrometern von der geschärften Spitze aufweist, wobei die keilförmig geschärfte Kante mit einer geschärften Spitze gebildet wird, die einen eingeschlossenen Winkel von weniger als 17 Grad bei einem Abstand von 40 µm (Mikrometer) von einer Spitze der geschärften Kante hat,
dadurch gekennzeichnet, daß die äußerste Spitze (70) einen Radius von weniger als 400 Å (Angström) hat und von zwei Facetten (62, 64) begrenzt ist, die jede eine Länge von mindestens etwa 0,1 Mikrometer haben und einen eingeschlossenen Winkel von mindestens sechzig Grad festlegen.

2. Verfahren zum Herstellen einer Rasierklinge nach Anspruch 1, dadurch gekennzeichnet, daß das feste Targetteil (98) ein hochreines Graphit-Target ist und der Schritt des Sputterns einschließt: achsgerades Einstellen einer Verschlußblende (116)



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zwischen dem hochreinen Graphit-Target (98) und dem Substrat in einer In rtgas-Umgebung; Aufbringen von elektrischer Energie auf das hochreine Graphit-Target und Öffnen der Verschlußblende (116) für eine vorbestimmte Zeitdauer, während die Vorspannung an das Substrat angelegt wird, um die Schicht aus Diamant oder diamantähnlichem Material zu erzeugen.

3. Verfahren zum Herstellen einer Rasierklinge nach einem der vorgenannten Ansprüche 1 und 2, gekennzeichnet durch den Schritt des Abscheidens einer Zwischenschicht aus Molybdän auf der keilförmig geschärften Kante bis zu einer Dicke von 300 Å (Angström) oder weniger vor dem Abscheiden der Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial, welcher Schritt des Abscheiden der Zwischenschicht aus Molybdän einschließt: Anordnen eines Molybdän-Targets (96) in der Kammer (74) und Anordnen einer Verschlußblende (114) in achsgerader Einstellung zwischen dem Molybdän-Target (96) und dem Substrat; Aufbringen von elektrischer Energie auf das Molybdän-Target (96) und Öffnen der Verschlußblende (114) für eine vorbestimmte Zeitdauer zum Abscheiden der Zwischenschicht aus Molybdän.

4. Verfahren zum Herstellen einer Rasierklinge nach einem der vorgenannten Ansprüche 1 bis 3, ferner einschließend den Schritt des Abscheidens einer haftenden Polymer-Beschichtung (72) auf der Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60).

5. Rasierklinge (16, 20, 44), einschließend ein Substrat (50), welches darauf eine keilförmig geschärfte Kante aufweist, wobei die keilförmig geschärfte Kante eine geschärfte Spitze (52) und eine Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) einschließt, die auf der geschärften Kante des Substrats erzeugt ist, wobei die Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) eine Dicke von mindestens 1.200 Å (Angström) von der geschärften Spitze (52) bis zu einem Abstand von vierzig Mikrometern von der geschärften Spitze (52) aufweist, wobei die Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) eine äußerste Spitze (70) mit einem Höhe/Breite-Verhältnis im Bereich von 1:1 bis 3:1 einschließt, wobei die geschärfte Spitze (52) einen eingeschlossenen Winkel von weniger als siebzehn Grad bei einem Abstand von vierzig Mikrometern von der geschärften Spitze (52) aufweist,

dadurch gekennzeichnet, daß die geschärfte Spitze (52) eine L5-Naßwollfilz-Schneidkraft von weniger als 0,8 kgf, eine Trockenfilz (zehn Schnitte)-Kantenschädigung von weniger als fünfzig kleinen Kantenschädigungsbereichen mit größerer Abmessung oder Tiefe hat und einen Radius an der äußersten Spitze von weniger als 400 Å (Angström) hat, die äußerste Spitze (70) von Facetten (62, 64) begrenzt ist, die eine Länge von mindestens etwa 0,1 Mikrometer und einen eingeschlossenen Winkel von mindestens 60 Grad haben.

6. Rasierklinge nach Anspruch 5, gekennzeichnet durch eine Zwischenschicht aus Molybdän (58), abgeschieden auf der keilförmig geschärften Kante, welche Zwischenschicht aus Molybdän bis zu einer Dicke von 300 Å (Angström) oder weniger abgeschieden ist, wobei die Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial (60) auf dieser Molybdän-Zwischenschicht (58) abgeschieden wird.

7. Rasierklinge nach einem der vorgenannten Ansprüche 5 und 6, ferner einschließend eine Schicht aus haftendem Polymer (72) auf dieser Schicht aus Diamant oder diamantähnlichem Kohlenstoffmaterial.

8. Rasiereinheit (10, 30), einschließend eine Tragkonstruktion (12, 32), die beabstandete, auf die Haut aufsetzende Oberflächen (14, 26, 34, 36) festlegt, eine oder mehrere Rasierklingenkonstruktionen (40, 42), die auf der Tragkonstruktion aufgebaut sind und zwischen den auf die Haut aufsetzenden Oberflächen angeordnet sind, wobei jede der einen oder mehreren Rasierklingenkonstruktionen (40, 42) eine Rasierklinge (16, 20, 40) nach einem der Ansprüche 5 bis 7 einschließt.

**Revendications**

1. Procédé de formation d'une lame de rasoir (16, 20, 44) comprenant l'abrasion mécanique d'un substrat (50) pour la formation d'un bord aiguisé en forme de coin sur le substrat, ayant un bout (52) dont le rayon est inférieur à 120 nm (1 200 Å), la formation d'une couche de diamant ou d'un matériau de carbone analogue à du diamant (60) sur le bord aiguisé du substrat par positionnement du substrat et d'un organe formant une cible solide (98) dans une chambre (74), et la pulvérisation de l'organe formant une cible solide pour la création d'atomes de carbone destinés à former la couche de diamant ou du matériau de carbone analogue à du diamant (60) sur le bord aiguisé du substrat à partir des atomes de carbone lors de l'application d'une polarisation à haute fréquence au substrat, la couche de diamant ou du matériau de carbone analogue à du diamant (60) formant un bout extrême (70) ayant un rapport d'allongement compris entre 1/1 et 3/1, la couche de diamant ou de matériau de carbone



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analogue à du diamant ayant une épaisseur d'au moins 120 nm (1 200 Å) du bout aiguisé du substrat à une distance de 40 µm du bout aiguisé, le bord aiguisé en forme de coin étant formé avec un bout aiguisé ayant un angle inclus inférieur à 17° à une distance de 40 µm du bout du bord aiguisé, caractérisé en ce que le bout extrême (70) a un rayon inférieur à 40 nm (400 Å) et est délimité par deux facettes (62, 64) ayant chacune une longueur d'au moins 0,1 µm environ et délimitant un angle inclus d'au moins 60°.

2. Procédé de formation d'une lame de rasoir selon la revendication 1, caractérisé en ce que l'organe (98) formant la cible solide est une cible de graphite très pur, l'étape de pulvérisation comprenant l'alignement d'un obturateur (116) entre la cible de graphite très pur (98) et le substrat dans un milieu de gaz inerte, l'application d'énergie électrique à la cible de graphite très pur, et l'ouverture de l'obturateur (116) pendant une période prédéterminée avec application de la polarisation au substrat pour la formation de la couche de diamant ou du matériau de carbone analogue à du diamant.

3. Procédé de formation d'une lame de rasoir selon l'une quelconque des revendications 1 et 2, caractérisé par l'étape de dépôt d'une couche intermédiaire de molybdène sur le bord aiguisé en forme de coin avec une épaisseur de 30 nm (300 Å) ou moins avant le dépôt de la couche de diamant ou du matériau de carbone analogue à du diamant, l'étape de dépôt de la couche intermédiaire de molybdène comprenant le positionnement d'une cible (96) de molybdène dans la chambre (74) et le positionnement d'un obturateur (114) dans l'alignement entre la cible de molybdène (96) et le substrat, l'application d'énergie électrique à la cible de molybdène (96), et l'ouverture de l'obturateur (114) pendant une période prédéterminée pour le dépôt de la couche intermédiaire de molybdène.

4. Procédé de formation d'une lame de rasoir selon l'une quelconque des revendications 1 à 3, comprenant en outre l'étape de dépôt d'un revêtement polymère adhérent (72) sur la couche de diamant ou du matériau de carbone analogue à du diamant (60).

5. Lame de rasoir (16, 20, 44) comprenant un substrat (50) ayant un bord aiguisé en forme de coin réalisé sur le substrat, le bord aiguisé en forme de coin comprenant un bout aiguisé (52) et une couche de diamant ou d'un matériau de carbone analogue à du diamant (60) formée sur le bord aiguisé du substrat, la couche de diamant ou du matériau de carbone analogue à du diamant (60) ayant une épaisseur d'au moins 120 nm (1 200 Å) entre le bout aiguisé (52) et un emplacement à une distance de 40 µm du bout aiguisé (52), la couche de diamant ou du matériau de carbone analogu à du diamant (60) comprenant un bout extrêm (70) qui a un rapport d'allongement compris entre environ 1/1 et 3/1, le bout aiguisé (52) ayant un angle inclus inférieur à 17° à une distance de 40 µm du bout aiguisé (52), caractérisée en ce que le bout aiguisé (52) a une force d'organe de coupe de feutre de laine humide L5 inférieure à 0,8 kg, une détérioration du bord par un feutre de laine sec (10 coupes) inférieure à cinquante petites régions de détérioration de bord et sans région de détérioration de plus grande dimension ou de plus grande profondeur, et un rayon du bout extrême inférieur à 40 nm (400 Å), le bout extrême (70) étant délimité par des facettes (62, 64) qui ont une longueur d'au moins 0,1 µm environ et un angle inclus d'au moins 60°.

6. Lame de rasoir selon la revendication 5, caractérisée par une couche intermédiaire de molybdène (58) déposée sur le bord aiguisé en forme de coin, la couche intermédiaire de molybdène étant déposée avec une épaisseur de 30 nm (300 Å) ou moins, la couche de diamant ou du matériau de carbone analogue à du diamant (60) étant déposée sur la couche intermédiaire de molybdène (58).

7. Lame de rasoir selon l'une des revendications 5 et 6, comprenant en outre une couche d'un polymère adhérent (72) placé sur la couche de diamant ou du matériau de carbone analogue à du diamant.

8. Unité de rasage (10, 30) comprenant une structure de support (12, 32) délimitant des surfaces espacées (14, 26, 34, 36) de contact avec la peau, et une ou plusieurs structures (40, 42) à lame de rasoir montées sur la structure de support et disposées entre les surfaces de contact avec la peau, chaque structure à lame de rasoir (40, 42) comprenant une lame de rasoir (16, 20, 44) selon l'une quelconque des revendications 5 à 7.



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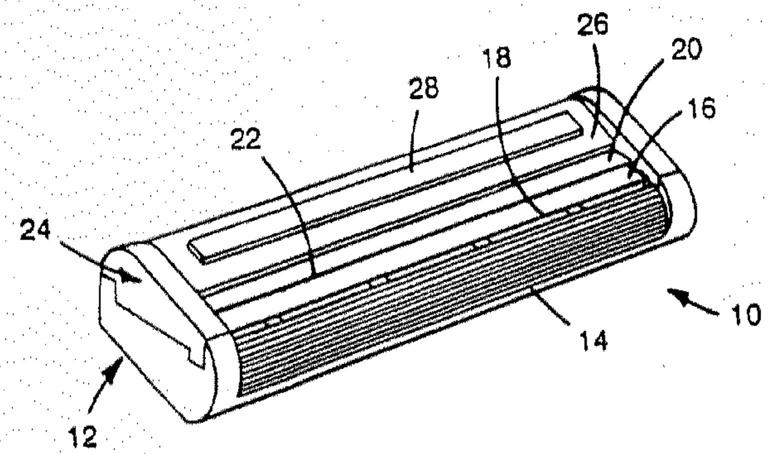


FIG. 1

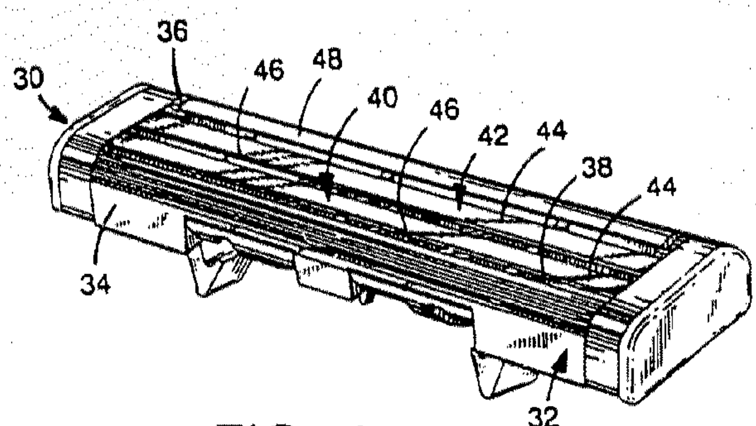


FIG. 2



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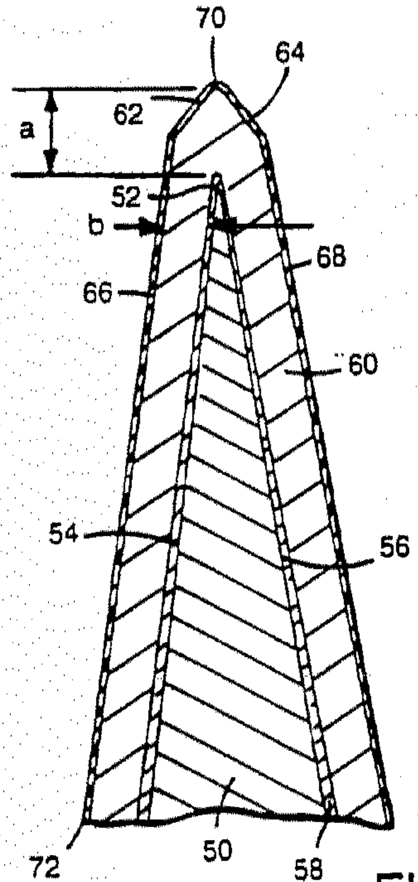


FIG. 3

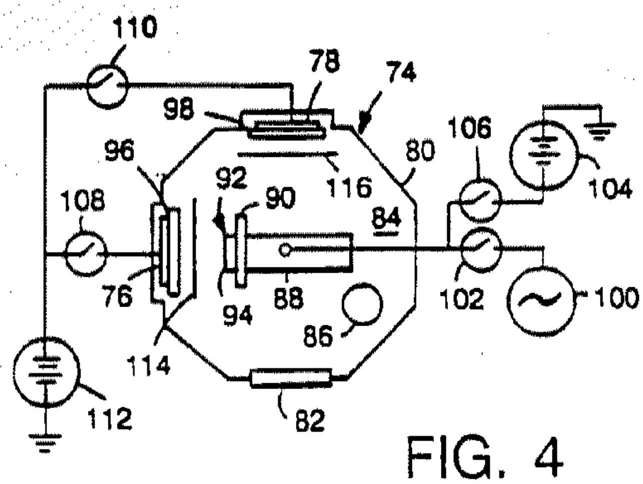


FIG. 4



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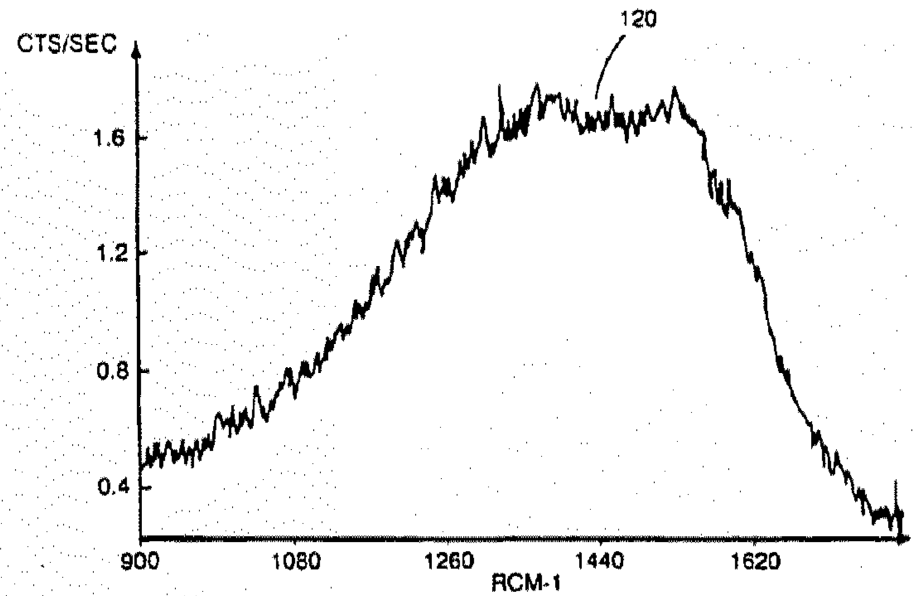
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CTS/SEC
1.6
1.2
0.8
0.4
900
1080
1260
1440
1620
RCM-1

FIG. 5

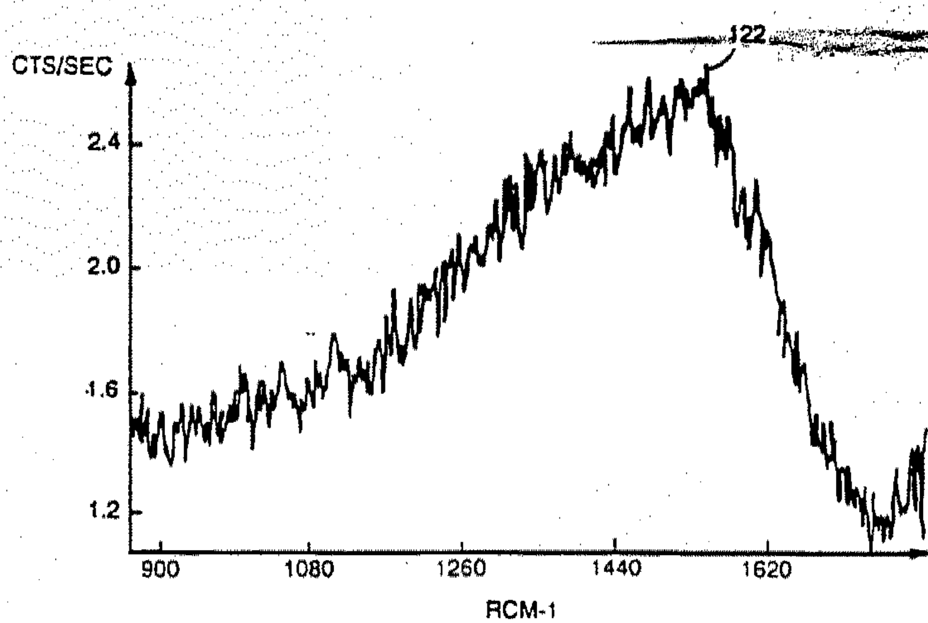
122
CTS/SEC
2.4
2.0
1.6
1.2
900
1080
1260
1440
1620
RCM-1

FIG. 6

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)


(51) International Patent Classification 5 : B26B 21/54, 21/40

A2

(11) International Publication Number: WO 92/19425

(43) International Publication Date: 12 November 1992 (12.11.92)

(21) International Application Number: PCT/US92/03330

(22) International Filing Date: 22 April 1992 (22.04.92)

(30) Priority data:

| | | |
|---|---|---|
| 692,010 | 26 April 1991 (26.04.91) | US |
| 759,812 | 26 August 1991 (26.08.91) | US |
| 835,251 | 13 February 1992 (13.02.92) | US |



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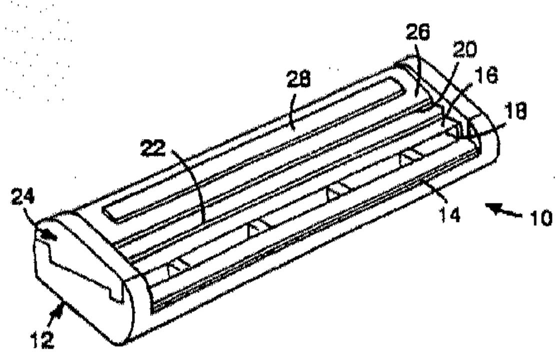
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent).

**Published**
*Without international search report and to be republished upon receipt of that report.*


(54) Title: IMPROVEMENTS IN OR RELATING TO RAZOR BLADES





(57) Abstract

A razor blade includes a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of nickel, niobium, silicon, silicon carbide, tantalum, vanadium, and alloys of such materials on the tip and flanks of the wedge-shaped edge, the thickness of the interlayer preferably being in the range of about 50-500 angstroms, and a layer of diamond or diamond-like carbon material on the interlayer that preferably has a thickness of about two thousand angstroms and that defines a tip radius of less than about 1000 angstroms.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IMPROVEMENTS IN OR RELATING TO RAZOR BLADES

This invention relates to improved razors and razor blades and to processes for producing razor blades or similar cutting tools with sharp and durable cutting edges.

A razor blade typically is formed of suitable substrate material such as metal or ceramic and an edge is formed with wedge-shape configuration with an ultimate edge or tip that has a radius of less than about 1,000 angstroms, the wedge shaped surfaces having an included angle of less than 30°. As shaving action is severe and blade edge damage frequently results and to enhance shavability, the use of one or more layers of supplemental coating material has been proposed for shave facilitation, and/or to increase the hardness and/or corrosion resistance of the shaving edge. A number of such coating materials have been proposed, such as polymeric materials and metals, as well as other materials including diamond and diamond-like carbon (DLC) material. Each such layer or layers of supplemental material must have adhesion compatibility so that each layer remains firmly adhered to the substrate throughout the useful life of the razor blade, and desirably provide characteristics such as improved shavability, improved hardness and/or corrosion resistance while not adversely affecting the geometry and cutting effectiv ness of the shaving edge.

It has been proposed to provide the cutting edges of razor blades with improved mechanical properties by applying to the sharpened edge of the substrate a coating of diamond or diamond-like carbon (DLC) material. Such materials may be characterized as having substantial sp3 carbon bonding; a mass density greater than 1.5 grams/$cm^3$; and a Raman peak at about 1331 $cm^{-1}$ (diamond) or about 1552 $cm^{-1}$ (DLC). However, such proposals have not been satisfactory due to the tendency of the diamond or diamond-like coating to have poor adhesion to and to peel off from the wedge-shaped edge of the substrate. It has been found that an interlayer of molybdenum provides excellent adhesion of the diamond or diamond-like carbon to the wedge-shaped edge of the substrate, but it has been found that under certain accelerated corrosion testing conditions such as immersion in hot distilled water at 80°C. for 16 hours, a diamond-like carbon coating can delaminate from a molybdenum interlayer and the steel blade substrate by what appears to be an electrochemical reaction.

In accordance with one aspect of the invention, there is provided a razor blade comprising a substrate with a wedge-shaped edge, an interlayer of material selected from the group consisting of molybdenum, nickel, niobium, silicon, silicon carbide, tantalum, vanadium, and alloys of such materials on the tip and flanks of the wedge-shaped edge, the thickness of the interlayer preferably being in the range of about 50-500 angstroms, and a layer of diamond or diamond-like carbon material on the interlayer that preferably has a thickness of at least about 1200 angstroms, defines a tip radius of less than about 400 angstroms and an aspect ratio in the rang f 1:1-3:1. The blade exhibits excellent shaving properties and

long shaving life.

In particular embodiments, the razor blade substrate is steel; the diamond or DLC coating is at least twice as hard as the metal substrate; the wedge-shaped edge is formed by a sequence of mechanical abrading steps; and the layers of interlayer material (a preferred material being niobium) and diamond or diamond-like carbon material are formed by sputtering material from targets of the interlayer material and graphite.

In accordance with another aspect of the invention, there is provided a process for forming a razor blade that includes the steps of providing a substrate, forming on an edge of the substrate a wedge-shaped sharpened edge that has an included angle of less than 30° and a tip radius (i.e. the estimated radius of the larger circle that may be positioned within the ultimate tip of the edge when such ultimate tip is viewed under a scanning electron microscope at magnifications of at least 25,000) preferably of less than 1,200 angstroms; depositing a layer of interlayer material selected from the group consisting of molybdenum, nickel, niobium, silicon, silicon carbide, tantalum, vanadium, and alloys of such materials on the sharpened edge; and depositing a layer of diamond or diamond-like material on the interlayer to provide a radius at the ultimate tip of the diamond or diamond-like carbon material of less than about 1,000 angstroms.

The interlayer and the diamond or DLC layer may be deposited by various techniques such as plasma decomposition of hydrocarbon gases, sputter deposition using ions from either a plasma or an ion gun to bombard a target, directly using a b am of carbon ions, and ion beam assisted deposition (IBAD) process using

either E-Beam or sputtering sources.

In a particular process, the substrate is mechanically abraded in a sequence of honing steps to form the sharpened edge; layers of niobium and diamond or diamond-like carbon material are successively deposited by sputtering; the niobium interlayer having a thickness of less than about five hundred angstroms, and the diamond or DLC coating on the niobium coated cutting edge having a thickness of at least about twelve hundred angstroms; the layer of diamond having a Raman peak at about 1331 $cm^{-1}$ and the layer of diamond-like carbon (DLC) material having a Raman peak at about 1550 $cm^{-1}$; substantial sp3 carbon bonding; and a mass density greater than 1.5 grams/$cm^3$; and an adherent polymer coating is applied on the diamond or DLC coated cutting edge.

In accordance with another aspect of the invention, there is provided a shaving unit that comprises blade support structure that has external surfaces for engaging user skin ahead and rearwardly of the blade edge or edges and at least one blade member secured to the support structure. The razor blade structure secured to the support structure includes a substrate with a wedge-shaped cutting edge defined by facets that have an included angle of less than seventeen degrees at a distance of forty micrometers from the sharpened tip, an interlayer selected from the group consisting of molybdenum, nickel, niobium, silicon, silicon carbide, tantalum, vanadium, and alloys of such materials and a layer of strengthening material on the interlayer that has a thickness of at least twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from th sharpen d tip, and an ultimate tip defined by facets that have lengths of at least about 0.1

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micrometer and define an included angle of at least sixty degrees, a radius at the ultimate tip of the strengthening material of less than 400 angstroms and an aspect ratio in the range of 1:1-3:1.

In a particular shaving unit, the razor blade structure includes two steel substrates, the wedge-shaped edges are disposed parallel to one another between the skin-engaging surfaces; a niobium interlayer is between the steel substrate and the edge strengthening layer and the edge strengthening layer is of diamond or DLC material; each niobium layer has a thickness of less than about five hundred angstroms; each diamond or DLC coating has a thickness of about two thousand angstroms (typically a range of 1800-2200 angstroms depending on processing parameters) and is characterized by substantial sp3 carbon bonding; a mass density greater than 1.5 grams/$cm^3$; and a Raman peak at about 1331 $cm^{-1}$ (diamond) or about 1550 $cm^{-1}$ (DLC); and an adherent polymer coating is on each layer of diamond or diamond-like carbon material.

The shaving unit may be of the disposable cartridge type adapted for coupling to and uncoupling from a razor handle or may be integral with a handle so that the complete razor is discarded as a unit when the blade or blades become dull. The front and rear skin engaging surfaces cooperate with the blade edge (or edges) to define the shaving geometry. Particularly preferred shaving units are of the types shown in U.S. Patent 3,876,563 and in U.S. Patent 4,586,255.

Other features and advantages of the invention will be seen as the following description of particular embodiments progresses, in conjunction with the drawings, in which:

Fig. 1 is a perspective view of a shaving unit in accordance with th inv ntion;

Fig. 2 is a perspective view of another shaving unit in accordance with the invention;

Fig. 3 is a diagrammatic view illustrating one example of razor blade edge geometry in accordance with the invention;

Fig. 4 is a diagrammatic view of apparatus for the practice of the invention; and

Figs. 5 and 6 are Raman spectra of DLC material deposited with the apparatus of Fig. 4.

## Description of Particular Embodiments

With reference to Fig. 1, shaving unit 10 includes structure for attachment to a razor handle, and a platform member 12 molded of high-impact polystyrene that includes structure defining forward, transversely-extending skin engaging surface 14. Mounted on platform member 12 are leading blade 16 having sharpened edge 18 and following blade 20 having sharpened edge 22. Cap member 24 of molded high-impact polystyrene has structure defining skin-engaging surface 26 that is disposed rearwardly of blade edge 22, and affixed to cap member 24 is shaving aid composite 28.

The shaving unit 30 shown in Fig. 2 is of the type shown in Jacobson U.S. Patent 4,586,255 and includes molded body 32 with front portion 34 and rear portion 36. Resiliently secured in body 32 are guard member 38, leading blade unit 40 and trailing blade unit 42. Each blade unit 40, 42 includes a blade member 44 that has a sharpened edge 46. A shaving aid composite 48 is frictionally secured in a recess in rear portion 36.

A diagrammatic view of the edge region of the blades 16, 20 and 44 is shown in Fig. 3. The blade includes stainless steel b dy p rtion 50 with a wedge-shaped sharpen d dge formed in a sequence of edge

forming honing operations that forms a tip portion 52 that has a radius typically less than 500 angstroms with facets 54 and 56 that diverge at an angle of about 13°. Deposited on tip 52 and facets 54, 56 is interlayer 58 of niobium that has a thickness of about 300 angstroms. Deposited on niobium interlayer 58 is outer layer 60 of diamond-like carbon (DLC) that has a thickness of about 2,000 angstroms, with facets 62, 64 that have lengths of about one-quarter micrometer each and define an included angle of about 80°, facets 62, 64 merging with main facet surfaces 66, 68 that are disposed at an included angle of about 13° and an aspect ratio (the ratio of the distance (a) from DLC tip 70 to stainless steel tip 52 and the width (b) of the DLC coating 60 at tip 52) of about 1.7. Deposited on layer 60 is an adherent telomer layer 72 that has a substantial as deposited thickness but is reduced to monolayer thickness during initial shaving.

Apparatus for processing blades of the type shown in Fig. 3 is diagrammatically illustrated in Fig. 4. That apparatus includes a DC planar magnetron sputtering system manufactured by Vac Tec Systems of Boulder, Colorado that has stainless steel chamber 74 with wall structure 80, door 82 and base structure 84 in which is formed port 86 coupled to a suitable vacuum system (not shown). Mounted in chamber 74 is carousel support 88 with upstanding support member 90 on which is disposed a stack of razor blades 92 with their sharpened edges 94 in alignment and facing outwardly from support 90. Also disposed in chamber 74 are support structure 76 for target member 96 of niobium (99.99% pure) and support structure 78 for target member 98 of graphite (99.999% pure). Targets 96 and 98 ar vertically disposed plates, each about twelve centim t rs wide and about thirty-seven centimeters

long. Support structures 76, 78 and 88 are electrically isolated from chamber 74 and electrical connections are provided to connect blade stack 92 to RF power supply 100 through switch 102 and to DC power supply 104 through switch 106; and targets 96 and 98 are connected through switches 108, 110, respectively, to DC magnetron power supply 112. Shutter structures 114 and 116 are disposed adjacent targets 96, 98, respectively, for movement between an open position and a position obscuring its adjacent target.

Carousel 88 supports the blade stack 92 with the blade edges 94 spaced about seven centimeters from the opposed target plate 96, 98 and is rotatable about a vertical axis between a first position in which blade stack 92 is in opposed alignment with niobium target 96 (Fig. 4) and a second position in which blade stack 92 is in opposed alignment with graphite target 98.

In a particular processing sequence, a stack of blades 92 (five centimeters high) is secured on support 90; chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; switch 102 is then closed and the blades 92 are RF cleaned in an argon environment for five minutes at a pressure of ten millitorr, an argon flow of 200 sccm and a power of 1.5 kilowatts; the argon flow is then reduced to 150 sccm at a pressure of 2.0 millitorr in chamber 74; switch 106 is closed to apply a DC bias of -25 volts on blades 92; switch 108 is closed to commence sputtering at one kilowatt power and shutter 114 in front of niobium target 96 is opened for thirty seconds to deposit a niobium layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 is then closed, switches 106 and 108 are opened, and carousel 88 is r tat d 90° to juxtapose th blade edges of blade stack 92 with graphite target 98. Pr ssure in chamber

74 is maintained at two millitorr with an argon flow of 150 sccm; switch 110 is closed to sputter graphite target 98 at 750 watts; switch 102 is closed to apply a 13.56 MHz RF bias of eight hundred watts (-420 volts DC self bias voltage) on blades 92, and concurrently shutter 116 is opened for twenty minutes to deposit a DLC layer 60 of about two thousand angstroms thickness on niobium layer 58. The DLC coating 60 had a radius at tip 70 of about 350 Angstroms that is defined by facets 62, 64 that have an included angle of about 80°, and an aspect ratio of about 1.9:1. As illustrated in Fig. 5, Raman spectroscopy of the coating material 60 deposited in this process shows a broad Raman peak 118 extending between about 1350 and 1530 $cm^{-1}$ wave numbers, a spectrum typical of DLC structure.

A coating 72 of polytetrafluoroethylene telomer is then applied to the DLC-coated edges of the blades. The process involves heating the blades in a neutral atmosphere of argon and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. Coatings 58 and 60 were firmly adherent to the blade body 50, provided low wet wool felt cutter force (the lowest of the first five cuts with wet wool felt (L5) being about 0.45 kilogram), and withstood repeated applications of wool felt cutter forces indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50, even after immersion in 80°C. distilled water for sixteen hours. Resulting blade elements 44 were assembled in cartridge units 30 of the type shown in Fig. 2 and shaved with excellent shaving results.

In another example, target 96 is molybdenum and target 98 is graphite. In a particular processing

PACE-037340

sequence with that system, chamber 74 is evacuated; the targets 96, 98 are cleaned by DC sputtering for five minutes; the blades 92 are then RF cleaned in an argon environment at a pressure of ten millitorr at a power of 1.5 kilowatts and an argon flow of 200 sccm; the argon flow reduced to 150 sccm at a pressure of two millitorr in chamber 74; shutter 114 in front of molybdenum target 96 is opened, and target 96 is sputtered at one kilowatt power with a bias of -150 volts on blades 82 for twenty-two seconds to deposit a molybdenum layer 58 of about 200 angstroms thickness on the blade edges 94. Shutter 114 is then closed, and carousel 88 is rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 is maintained at two millitorr with an argon flow of 150 sccm, shutter 116 is opened, and graphite target 98 is sputtered at 900 watts with a bias of -150 volts on blades 92 for 10 minutes to deposit a DLC layer 60 of about 800 angstroms thickness on molybdenum layer 58. As illustrated in Fig. 6, Raman spectroscopy of the coating material 60 deposited in this process shows a broad Raman peak 120 centered at about 1525 $cm^{-1}$ wave number, a spectrum typical of DLC structure. The DLC coating 60 was firmly adherent to the blade body 50 and withstood repeated applications of wool felt cutter forces, indicating that the DLC coating 60 is substantially unaffected by exposure to the severe conditions of this felt cutter test and remains firmly adhered to the blade body 50. Its tip 70 had a radius of about 700 angstroms and an aspect ratio of 1.7:1.

A coating 72 of polytetrafluoroethylene telomer was then applied to the DLC-coated edges of the blades in accordance with the teaching of U.S. Patent No. 3,518,110. This process involves heating the blad s in a n utral atmosphere such as nitrogen or

argon or a reducing atmosphere such as cracked ammonia and providing on the cutting edges of the blades an adherent and friction-reducing polymer coating of solid PTFE. The resulting blade elements 44 were assembled in cartridge units 30 of the type shown in Fig. 2 and shaved with excellent shaving results.

In another processing sequence, chamber 74 was evacuated; the targets 96, 98 were cleaned by DC sputtering for five minutes; the blades 82 were then RF cleaned in an argon environment at a pressure of ten millitorr at a power of 1.5 kilowatts and an argon flow of 200 sccm for two minutes; the argon flow reduced to 150 sccm at a pressure of two millitorr in chamber 74; shutter 114 in front of molybdenum target 96 was then opened; and target 90 was sputtered at one kilowatt power with a bias of -150 volts on blades 92 for thirty-two seconds to deposit a molybdenum layer 58 of about 300 angstroms thickness on the blade edges 94. Shutter 114 was closed and carousel 88 was rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 was maintained at two millitorr with an argon flow of 150 sccm, shutter 116 was opened, and graphite target 98 was sputtered at 500 watts with a bias of -100 volts on blades 92 for ten minutes to deposit a DLC layer 60 of about 1,000 angstroms thickness on molybdenum layer 58. The resulting blades had firmly adherent DLC coatings 60 and were shaved with excellent shaving results.

In another processing sequence, chamber 74 was evacuated; targets 96, 98 were cleaned by DC sputtering for five minutes; blades 92 were then RF cleaned in an argon environment at a pressure of ten millitorr at a power of 1.5 kilowatts and an argon flow of 200 sccm for two minutes; the argon flow reduced to 150 sccm at a pressure of two millitorr in chamber 74;

shutter 114 in front of molybdenum target 96 was then opened; and target 96 was sputtered to deposit a molybdenum layer 58 of about 200 angstroms thickness on the blade edges 94. Shutter 114 was closed and carousel 88 was rotated 90° to juxtapose blade stack 92 with graphite target 98. Pressure in chamber 74 was maintained at two millitorr with an argon flow of 150 sccm, shutter 116 was opened, and graphite target 98 was sputtered at 600 watts to deposit a DLC layer 60 of about 300 angstroms thickness on molybdenum layer 58. The DLC coatings 60 were firmly adherent on resulting blades, and the DLC tips 70 had a radius of about 500 angstroms.

While particular embodiments of the invention have been shown and described, various modifications will be apparent to those skilled in the art, and therefore, it is not intended that the invention be limited to the disclosed embodiments, or to details thereof, and departures may be made therefrom within the spirit and scope of the invention.

CLAIMS

1. A process for forming a razor blade comprising the steps of

providing a substrate,

forming a wedge-shaped sharpened edge on said substrate that has an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms;

depositing an interlayer of material selected from the group consisting of molybdenum, nickel, niobium, silicon, silicon carbide, tantalum, vanadium, and alloys of such materials on said sharpened edge; and depositing a layer of diamond or diamond-like carbon material on said interlayer.

2. The process of claim 1, wherein said interlayer on said cutting edge has a thickness of less than about five hundred angstroms, and said diamond or diamond-like carbon layer on said interlayer coated cutting edge has a thickness of at least twelve hundred angstroms from the sharpened tip of said substrate to a distance of forty micrometers from the sharpened tip.

3. The process of claims 1 or 2, wherein said substrate is of metal and said diamond or diamond-like carbon layer is at least twice as hard as said metal substrate.

4. The process of any preceding claim, wherein said layer of diamond or diamond-like carbon material is deposited in an argon atmosphere in an evacuated chamber in which graphite and niobium targets are located; said niobium target is energized, and an interlayer of niobium is deposited on said blade edge by sputtering; and said graphite target is then energized to deposit said layer of diamond or diamond-like carbon material on said niobium interlayer while an RF bias is applied to said substrate.

5. The process of any preceding claim, wherein said wedge-shaped edge has an included angle f l ss than 30° and a tip radius less than 1,200 angstroms; and said layer of

diamond or diamond-like carbon material has a radius at the ultimate tip of said diamond or diamond-like carbon material of less than about 400 angstroms.

6. The process of any preceding claim, wherein said diamond or diamond-like carbon layer on said sharpened edge has a thickness of about two thousand angstroms.

7. The process of any preceding claim, and further including the step of applying an adherent polymer coating on said diamond or diamond-like carbon coated sharpened edge.

8. A razor blade made according to the process of any preceding claim.

9. A razor blade of claim 8, wherein said layer of diamond or diamond-like carbon (DLC) material has a Raman peak at about 1331 $cm^{-1}$ (diamond) or about 1552 $cm^{-1}$ (DLC), an aspect ratio of less than about 3:1; substantial sp3 carbon bonding; and a mass density greater than 1.5 $grams/cm^3$.

10. A shaving unit comprising support structure that defines spaced skin-engaging surfaces, and razor blade structure according to either claim 8 or claim 9 secured to said support structure, said diamond or diamond-like carbon coated wedge-shaped edge being disposed between said skin-engaging surfaces.

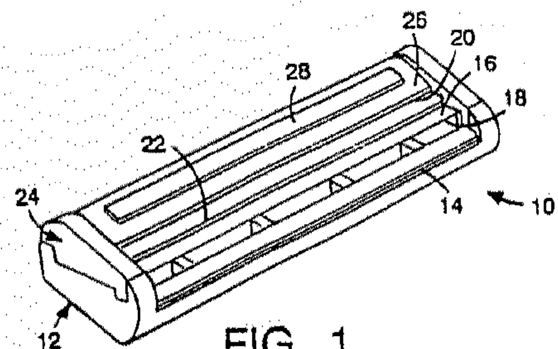


FIG. 1

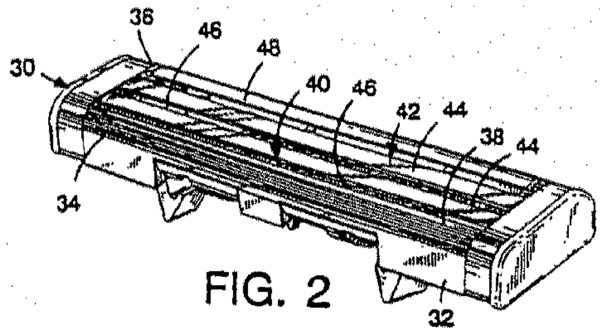


FIG. 2

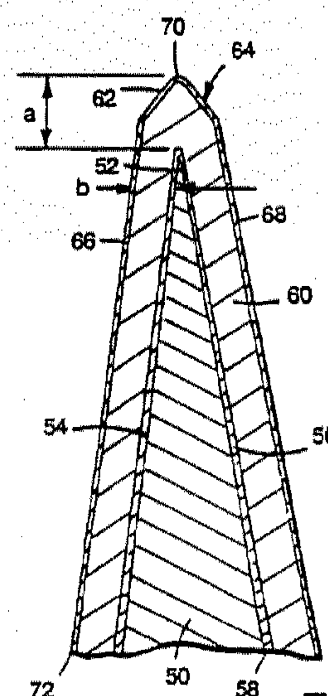


FIG. 3

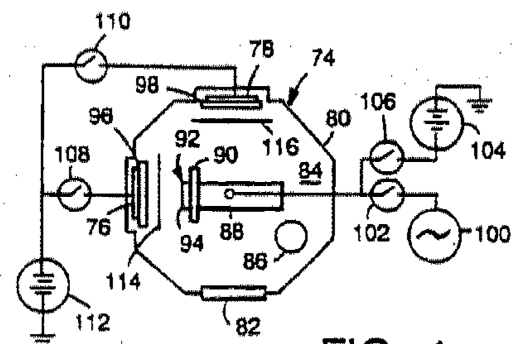


FIG. 4

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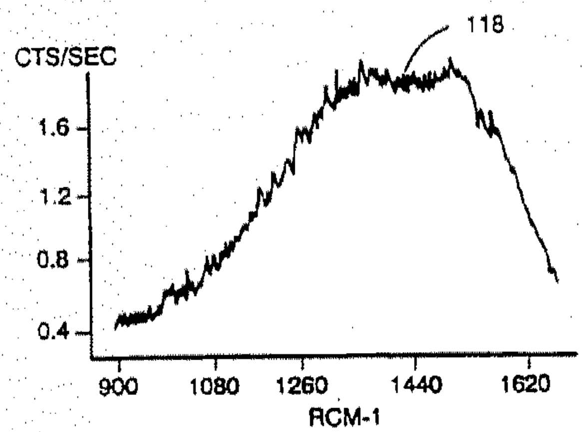


FIG. 5

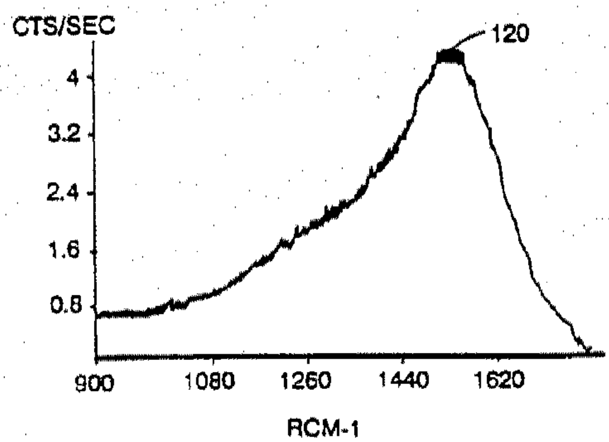


FIG. 6

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 04/08/2004

FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | 3 |

DATE MAILED: 04/08/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 10/379,264 | CLIPSTONE ET AL. |
| | Examiner | Art Unit |
| | Stephen Choi | 3724 |

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 1 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☐ Responsive to communication(s) filed on ____.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) 1-21 is/are pending in the application.

4a) Of the above claim(s) ____ is/are withdrawn from consideration.

5)☐ Claim(s) ____ is/are allowed.

6)☐ Claim(s) ____ is/are rejected.

7)☐ Claim(s) ____ is/are objected to.

8)☒ Claim(s) 1-21 are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on ____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1)☐ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date ____.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ____.

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: ____.

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

Group I. Claims 1, 3(1)-6(1), 7-8, 11(1), and 12 are, drawn to a razor blade with no overcoat layer, classified in class 30, subclass 346.53.

Group II. Claims 2, 3(2)-6(2), 9-10, 11(2), and 13 are, drawn to a razor blade with no interlayer, classified in class 30, subclass 350.

Group III. Claim 14 is, drawn to a method of making a razor blade, classified in class 76, subclass 104.1.

Group IV. Claims 15-21 are, drawn to a razor blade including 0.1 to 10 atomic percent of a dopant, classified in class 428, subclass 544.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions of groups I and II are related as subcombinations disclosed as usable together in a single combination. The subcombinations are distinct from each other if they are shown to be separately usable. In the instant case, invention of group I could be used with an interlayer, and conversely, invention of group II could be used with an overcoat layer. See MPEP § 806.05(d).

3. Inventions of groups I-II, IV and group III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case, the process as

claimed can be used to make other and materially different product such as a razor blade with an overcoat layer, an interlayer, or a razor blade not requiring 0.1 to 10 atomic percent of dopant.

4. Inventions of groups I-II and group IV are related as subcombinations disclosed as usable together in a single combination. The subcombinations are distinct from each other if they are shown to be separately usable. In the instant case, invention of groups I and II could have a razor blade not requiring 0.1 to 10 atomic percent of dopant. See MPEP § 806.05(d).

5. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification and because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

6. This application contains claims directed to the following patentably distinct species of the claimed invention:

Species A - The embodiment shown on Figure 1.

Species B - The embodiment shown on Figure 3.

Species C - a razor blade comprising a coating of carbon-containing material being DLC.

Species D - a razor blade comprising a coating of carbon-containing material being selected from the group consisting of diamond and amphorous diamond.

Species E - a razor blade comprising a dopant being selected from the group consisting of titanium, niobium, tungsten, molybdenum, and silicon.

Species F - a razor blade comprising a dopant being chromium.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, no claims are generic.

Applicant is advised that a reply to this requirement must include an identification of the species that is elected consonant with this requirement, and a listing of all claims readable thereon, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141. If claims are added after the election, applicant must indicate which are readable upon the elected species. MPEP § 809.02(a).

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over

the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

7. Applicant is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

8. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to S. Choi whose telephone number is 703-306-4523. The examiner can normally be reached on Monday thru Friday between 9am and 5pm. If attempts to reach the examiner are unsuccessful, the examiner's supervisor, Allan Shoap can be reached on 703-308-1082.

In lieu of mailing, it is encouraged that all formal responses be faxed to 703-872-9306. Any inquiry of a general nature or relating to the status of this application should be directed to the receptionist whose telephone number is 703-308-1148.

sc
April 7, 2004

STEPHEN CHOI
PRIMARY EXAMINER

3724



49

OIPE JC10 APR 22 2004 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO RESTRICTION REQUIREMENT

Responsive to the action mailed April 8, 2004, please amend the claims as follows:

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CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

April 20, 2004
Date of Deposit

Sherry L Hunt
Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Cancelled).

2. (Original) A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating of a carbon-containing material, doped with chromium, on the cutting edge; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

3. (Currently Amended) The razor blade of claim[[s 1 or]] 2, wherein the coating of a carbon-containing material includes from 0.1 to 10 atomic percent chromium.

4. (Currently Amended) The razor blade of claim[[s 1 or]] 2, wherein the coating of a carbon-containing material includes from 1 to 5 atomic percent chromium.

5. (Currently Amended) The razor blade of claim[[s 1 or]] 2, wherein the coating of a carbon-containing material is diamond-like carbon.

6. (Currently Amended) The razor blade of claim[[s 1 or]] 2, wherein the coating of a carbon-containing material is selected from the group consisting of diamond and amphorous diamond.

7.-8. (Cancelled).

9. (Original) The razor blade of claim 2, further comprising an overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.

10. (Original) The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. (Currently Amended) The razor blade of claim[s 1 or]] 2, wherein the coating of a carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. (Cancelled).

13. (Original) A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14.-21. (Cancelled).

REMARKS

Applicants elect the Group II claims, without traverse. Applicants further elect Species C. The non-elected claims have been cancelled. All pending claims cover Species C.

Please apply any charges or credits to deposit account 06 1050.

Respectfully submitted,

Date: April 20, 2004

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

20844811.doc

O I P E JC10
APR 22 2004
PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 00216-607001 / Case 8104

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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INFORMATION DISCLOSURE STATEMENT

Applicants submit the references listed on the attached form PTO-1449.

This statement is being filed before the receipt of a first Office action on the merits.

Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: April 20, 2004

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

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April 20, 2004
Date of Deposit

Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

PACE-037358

OIPE JC10
APR 2 2 2004
PATENT & TRADEMARK OFFICE



| Substitute Form PTO-1449 (Modified) — U.S. Department of Commerce, Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant: Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date: March 4, 2003 | Group Art Unit: 3724 |

## U.S. Patent Documents

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| | AA | 6,649,246 | 11/18/03 | Hayashi | | | |
| | AB | 6,548,172 | 04/15/03 | David et al. | | | |
| | AC | 6,030,904 | 02/29/00 | Grill et al. | | | |
| | AD | 5,507,760 | 04/16/96 | Wynne et al. | | | |
| | AE | | | | | | |
| | AF | | | | | | |
| | AG | | | | | | |
| | AH | | | | | | |
| | AI | | | | | | |
| | AJ | | | | | | |
| | AK | | | | | | |

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## Foreign Patent Documents or Published Foreign Patent Applications

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| | AL | | | | | | | |
| | AM | | | | | | | |
| | AN | | | | | | | |
| | AO | | | | | | | |
| | AP | | | | | | | |

## Other Documents (include Author, Title, Date, and Place of Publication)

| Examiner Initial | Desig. ID | Document |
|---|---|---|
| | AQ | Sonnenberg et al., U.S.S.N. 10/361,951, filed February 10, 2003 |
| | AR | |
| | AS | |
| | AT | |

| Examiner Signature | Date Considered |
|---|---|
| | |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

BEST AVAILABLE COPY

# PATENT APPLICATION FEE DETERMINATION RECORD
Effective January 1, 2003

Application or Docket Number: 10,379264

## CLAIMS AS FILED - PART I

| | (Column 1) | (Column 2) |
|---|---|---|
| TOTAL CLAIMS | 21 | |
| FOR | NUMBER FILED | NUMBER EXTRA |
| TOTAL CHARGEABLE CLAIMS | 26 minus 20= | * 6 |
| INDEPENDENT CLAIMS | 6 minus 3 = | * 3 |
| MULTIPLE DEPENDENT CLAIM PRESENT | | |

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE OR OTHER THAN SMALL ENTITY

| SMALL ENTITY RATE | FEE | | OTHER THAN SMALL ENTITY RATE | FEE |
|---|---|---|---|---|
| BASIC FEE | $375 | OR | BASIC FEE | $750 |
| X$ 9= | | OR | X$18= | 108 |
| X42= | | OR | X84= | 252 |
| +140= | | OR | +280= | 280 |
| TOTAL | | OR | TOTAL | 139[illegible] |

## CLAIMS AS AMENDED - PART II

4/22/6[illegible]

**AMENDMENT A**

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * 9 | Minus | ** 26 | = |
| Independent | * 2 | Minus | *** 6 | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | |

| SMALL ENTITY RATE | ADDITIONAL FEE | | OTHER THAN SMALL ENTITY RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

**AMENDMENT B**

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | |

| RATE | ADDITIONAL FEE | | RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

**AMENDMENT C**

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | |

| RATE | ADDITIONAL FEE | | RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

OIPE JC60 JUN 2 5 2004 PATENT & TRADEMARK OFFICE

3724

Attorney's Docket No.: 00216-607001 / Case 8104

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## INFORMATION DISCLOSURE STATEMENT

Applicants submit the references listed on the attached form PTO-1449.

This statement is being filed before the receipt of a first Office action on the merits.

Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: June 23, 2004

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

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CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

June 23, 2004
Date of Deposit

Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

OIPE JUN 2 5 2004 PATENT & TRADEMARK OFFICE

## U.S. Patent Documents

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| | AA | US 2004/0099120 A1 | 05/27/04 | Yamada et al. | | | |
| | AB | | | | | | |
| | AC | | | | | | |
| | AD | | | | | | |
| | AE | | | | | | |
| | AF | | | | | | |
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| | AH | | | | | | |
| | AI | | | | | | |
| | AJ | | | | | | |
| | AK | | | | | | |

## Foreign Patent Documents or Published Foreign Patent Applications

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Yes | No |
| | AL | | | | | | | |
| | AM | | | | | | | |
| | AN | | | | | | | |
| | AO | | | | | | | |
| | AP | | | | | | | |

## Other Documents (include Author, Title, Date, and Place of Publication)

| Examiner Initial | Desig. ID | Document |
|---|---|---|
| | AQ | |
| | AR | |
| | AS | |
| | AT | |

| Examiner Signature | Date Considered |
|---|---|
| | |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Substitute Disclosure Form (PTO-1449)

3724

Attorney's Docket No.: 00216-607001 / Case 8104

OIPE JUN 2 5 2004 JC60 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Prior to examination, please amend the application as indicated on the following pages.

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

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June 23, 2004
Date of Deposit

Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Cancelled).

2. (Currently Amended) A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating of a carbon-containing material, doped with chromium, on the cutting edge, the coating including from 0.1 to 10 atomic percent chromium; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

3. (Cancelled).

4. (Previously Presented) The razor blade of claim 2, wherein the coating of a carbon-containing material includes from 1 to 5 atomic percent chromium.

5. (Previously Presented) The razor blade of claim 2, wherein the coating of a carbon-containing material is diamond-like carbon.

6. (Previously Presented) The razor blade of claim 2, wherein the coating of a carbon-containing material is selected from the group consisting of diamond and amphorous diamond.

7.-8. (Cancelled).

9. (Original) The razor blade of claim 2, further comprising an overcoat layer between the coating of a carbon-containing material and the coating of polytetrafluoroethylene.

10. (Original) The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. (Previously Presented) The razor blade of claim 2, wherein the coating of a carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. (Cancelled).

13. (Original) A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating of a carbon-containing material doped with chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14.-21. (Cancelled).

## REMARKS

Please apply any other charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: June 23, 2004

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

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| L Number | Hits | Search Text | DB | Time stamp |
|---|---|---|---|---|
| 10 | 9 | (no near2 interlayer$1) and razor$1 | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:04 |
| 11 | 13 | (dop$5 near5 chromium) and polytetrafluoroethylene and blade$1 | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:22 |
| 13 | 2 | (diamond or dlc) near5 (dop$5 near3 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:39 |
| 14 | 5 | (diamond or dlc) near10 (dop$5 near3 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:41 |
| 15 | 7 | (diamond$1 or dlc$1) near10 (dop$5 near5 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:43 |
| 16 | 11 | (diamond$1 or dlc$1) near10 (dop$5 near10 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:44 |
| 17 | 53 | (diamond$1 or dlc$1) near20 (dop$5 near20 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:45 |
| 18 | 55 | (diamond$1 or dlc$1) near30 (dop$5 near30 chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:45 |
| 19 | 116 | (diamond$1 or dlc$1) same (dop$5 same chromium) | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 14:52 |
| 28 | 15 | (overcoat$3 same chromium) and razor$1 | USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB | 2004/06/27 16:14 |

PALM INTRANET

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Date:
6/27/2004
Time: 16:42:43

# Inventor Name Search

Enter the first few letters of the Inventor's Last Name.
Additionally, enter the first few letters of the Inventor's First name.

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| hahn | steve | Search |

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6/27/2004
Time: 16:42:43

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|---|---|---|
| liu | yiqian | Search |

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PALM INTRANET

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Date: 6/27/2004
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# Inventor Name Search

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| Last Name | First Name | |
|---|---|---|
| zhuk | andrew | Search |

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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 07/01/2004

FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | |

DATE MAILED: 07/01/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/379,264 | CLIPSTONE ET AL. | |
| | **Examiner** | **Art Unit** | |
| | Stephen Choi | 3724 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *22 April 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *2-6,9-11 and 13* is/are pending in the application.

4a) Of the above claim(s) ____ is/are withdrawn from consideration.

5)☐ Claim(s) ____ is/are allowed.

6)☒ Claim(s) *2-5,9-11 and 13* is/are rejected.

7)☐ Claim(s) ____ is/are objected to.

8)☐ Claim(s) ____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *04 March 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *10/3/03 & 4/22/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: ____.

## DETAILED ACTION

### *Election/Restrictions*

1. Applicant's election without traverse of Group II, Species C in the reply filed on 22 April 2004 is acknowledged.

### *Claim Rejections - 35 USC § 102*

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 2-6, 11, and 13 are rejected under 35 U.S.C. 102(b) as being anticipated by Goel et al. (US 5,795,648).

Goel discloses all the recited elements of the invention including:

a) a substrate with a cutting edge defined by a sharpened tip and adjacent facets (20);

b) a coating of a carbon-containing material, doped with chromium, on the cutting edge (21);

c) a coating of polytetratluoroethylene on the coating of a carbon-containing material (22), wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge (Figure 5). Regarding claims 3-4, col. 5, lines 34-54. Regarding claim 11, col. 3, lines 34-43 and col. 4, lines 14-16. Regarding claim 13, Figure 7.

### *Claim Rejections - 35 USC § 103*

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goel et al. (US 5,795,648) in view of Clipstone et al. (US 6,684,513).

Goel discloses the invention substantially as claimed except for an overcoat layer comprising chromium. Clipstone '513 discloses an overcoat layer comprising chromium. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the blade of Goel with the overcoat chromium layer as taught by Clipstone in order to provide improved adhesion of PTFE layer.

## *Conclusion*

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Decker et al. '593, Wang, Bray et al., and Trankiem et al. are cited to show related devices.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen Choi whose telephone number is 703-306-4523. The examiner can normally be reached on Monday-Friday 9:00-3:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Allan Shoap can be reached on 703-308-2187. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

sc
27 June 2004

STEPHEN CHOI
PRIMARY EXAMINER

Sheet 1 of 2

Substitute Form PTO-1449 (Modified)

U.S. Department of Commerce Patent and Trademark Office

# Information Disclosure Statement by Applicant

(Use several sheets if necessary)

(37 CFR 1.98(b))

OIPE OCT 31 2003 PATENT & TRADEMARK OFFICE

| Attorney's Docket No. | Application No. |
|---|---|
| 00216-607001 | 10/379,264 |
| Applicant | |
| Colin Clipstone et al. | |
| Filing Date | Group Art Unit |
| March 4, 2003 | 3724 |

## U.S. Patent Documents

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| h | AA | 5,985,459 | 11/16/99 | Kwiecien et al. | — | — | |
| | AB | 5,918,369 | 07/06/99 | Apprille, Jr. et al. | — | — | |
| h | AC | 5,940,975 | 08/24/99 | Decker et al. | — | — | |
| | AD | 5,799,549 | 09/01/98 | Decker et al. | — | — | |
| | AE | 5,669,144 | 09/23/97 | Hahn et al. | — | — | |
| | AF | 5,497,550 | 03/12/96 | Trotta et al. | — | — | |
| | AG | 5,480,527 | 01/02/96 | Welty | — | — | |
| h | AH | 5,295,305 | 03/22/94 | Hahn et al. | — | — | |
| | AI | 5,263,256 | 11/23/93 | Trankiem | — | — | |
| | AJ | 5,232,568 | 08/03/93 | Parent et al. | — | — | |
| | AK | 5,142,785 | 09/01/92 | Grewal et al. | — | — | |
| | AL | 5,032,243 | 07/16/91 | Bache et al. | — | — | |
| | AM | 4,960,643 | 10/02/90 | Lemelson | — | — | |
| | AN | 4,933,058 | 06/12/90 | Bache et al. | — | — | |
| | AO | 4,416,912 | 11/22/83 | Bache | — | — | |
| | AP | 3,911,579 | 10/14/75 | Lane et al. | — | — | |
| | AQ | 3,835,512 | 10/01/74 | Sanderson | — | — | |
| | AR | 3,837,896 | 09/24/74 | Lindstrom et al. | — | — | |
| | AS | 3,774,703 | 11/27/73 | Sanderson | — | — | |
| | AT | 3,754,329 | 08/28/73 | Lane | — | — | |
| | AU | 3,743,551 | 07/03/73 | Sanderson | — | — | |
| | AV | 3,508,957 | 04/28/70 | Blochl | — | — | |
| | AW | 3,480,483 | 11/25/69 | Wilkinson | — | — | |
| | AX | 3,345,202 | 10/03/67 | Kiss et al. | — | — | |

| Examiner Signature | Date Considered |
|---|---|
| Alvi | 6/27/04 |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Substitute Disclosure Form (PTO-1449)

| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR 1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

OIPE OCT 3 1 2003 PATENT & TRADEMARK OFFICE

**Foreign Patent Documents or Published Foreign Patent Applications**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| h | BA | EP 0 884 142 A1 | 12/16/98 | EPO | — | — | | |
| | BB | EP 0 591 339 B1 | 08/12/98 | EPO | — | — | | |
| | BC | WO 92/19425 | 11/12/92 | PCT | — | — | | |

**Other**

| Examiner Initial | Desig. ID | Description |
|---|---|---|
| h | BD | Kai K-3^bpc SR Razor Cartridge, June 1, 2001 |
| | BE | DuPont Material Safety Data Sheet, "Krytox LW-1200", June 15, 1998 |
| | BF | Wei et al., "Microstructure and wear resistance of doped diamond like carbon prepared by pulsed laser deposition", Mat. Res. Symp. Proc., Vol. 505, p. 331-336, 1998 |
| | BG | Vassell et al., "Characterization of silicon-stabilized amphorous hydrogenated carbon", Journal of Material Engineering and Performance, vol. 6(4), pp. 426-432, 1997 |
| | BH | Deng et al., "Reactive sputtred titanium carbide/nitride and diamond like carbon coatings", J. Vac. Sci. Technol., p. 2073-2077, 1998 |
| | BI | Meneve et al., "Friction and wear behavior of amphorous hydrogenated Si1-xCx films", Surface and Coatings Technology, 62, pp. 577-582, 1993 |

| Examiner Signature | Date Considered |
|---|---|
| Alir | 6/27/04 |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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Sheet 1 of 1

| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

**U.S. Patent Documents**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| h | AA | 6,649,246 | 11/18/03 | Hayashi | — | — | |
| | AB | 6,548,172 | 04/15/03 | David et al. | — | — | |
| | AC | 6,030,904 | 02/29/00 | Grill et al. | — | — | |
| | AD | 5,507,760 | 04/16/96 | Wynne et al. | — | — | |
| | AE | | | | | | |
| | AF | | | | | | |
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| | AJ | | | | | | |
| | AK | | | | | | |

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**Foreign Patent Documents or Published Foreign Patent Applications**

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|---|---|---|---|---|---|---|---|---|
| | AL | | | | | | | |
| | AM | | | | | | | |
| | AN | | | | | | | |
| | AO | | | | | | | |
| | AP | | | | | | | |

**Other Documents (include Author, Title, Date, and Place of Publication)**

| Examiner Initial | Desig. ID | Document |
|---|---|---|
| h | AQ | Sonnenberg et al., U.S.S.N. 10/361,951, filed February 10, 2003 |
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| Examiner Signature | Date Considered 6/27/04 |
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| EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. | |

Substitute Disclosure Form (PTO-1449)

| Notice of References Cited | Application/Control No. 10/379,264 | Applicant(s)/Patent Under Reexamination CLIPSTONE ET AL. | |
|---|---|---|---|
| | Examiner Stephen Choi | Art Unit 3724 | Page 1 of 1 |

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**NON-PATENT DOCUMENTS**

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

| **Search Notes** | Application No. 10/379,264 | Applicant(s) CLIPSTONE ET AL. |
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| | Examiner Stephen Choi | Art Unit 3724 |

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**SEARCH NOTES (INCLUDING SEARCH STRATEGY)**

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## *Index of Claims*

| Application No. | Applicant(s) |
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| 10/379,264 | CLIPSTONE ET AL. |
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Attorney's Docket No.: 00216-607001 / Case 8104

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## INFORMATION DISCLOSURE STATEMENT

Applicants submit the references listed on the attached form PTO-1449. A copy of a communication from a foreign patent office in a counterpart application is also enclosed.

This statement is being filed after a first Office action on the merits, but before receipt of a final Office action or a Notice of Allowance. I, the undersigned, hereby certify that each item of information contained in this statement was cited in a communication from a foreign patent office in a counterpart foreign application, the communication being dated July 23, 2004, which is not more than three months prior to the filing of this statement. Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 8/31/04

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I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

August 31, 2004
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Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

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| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
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| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

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| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
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| | AA | 6,110,532 | 08/29/00 | Causton et al. | | | |
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## Foreign Patent Documents or Published Foreign Patent Applications

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
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| | AL | WO 01/64406 | 09/07/01 | PCT | | | | |
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## Other Documents (include Author, Title, Date, and Place of Publication)

| Examiner Initial | Desig. ID | Document |
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EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Substitute Disclosure Form (PTO-1449)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/64406 A2

(51) International Patent Classification⁷: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,421 29 February 2000 (29.02.2000) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/515,421 (CON)
Filed on 29 February 2000 (29.02.2000)

(71) Applicant (for all designated States except US): THE GILLETTE COMPANY [US/US]; Prudential Tower Building, Boston, MA 02199 (US).

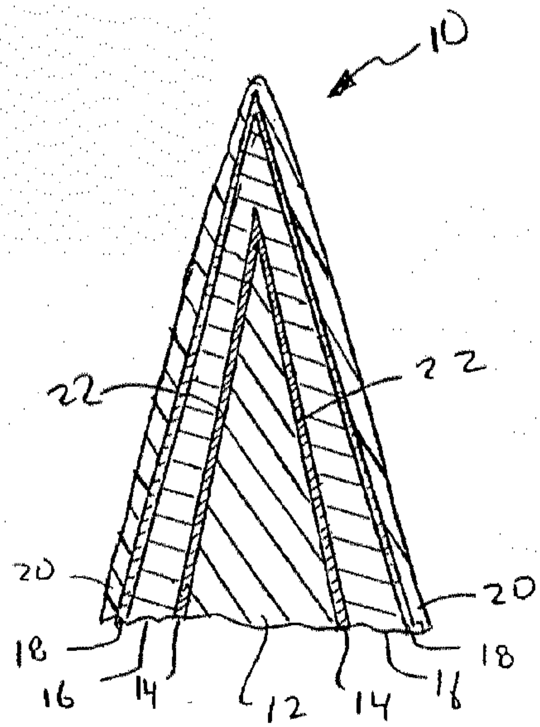
(72) Inventors; and
(75) Inventors/Applicants (for US only): SONNENBERG, Neville [US/US]; 101 Hanson Road, Newton, MA 02459 (US). ZHUK, Andrew [RU/US]; 117 Central Street, Apt. F-11, Acton, MA 01720 (US). WHITE, Charles [US/US]; 72 Forest Hill Avenue, Lynnfield, MA 01940 (US). HAHN, Steven [US/US]; 7 Trinity Court, Wellesley, MA 02481 (US). CLIPSTONE, Colin, John [GB/US]; 154 Newton Street, Weston, MA 02493 (US).

(74) Agents: GALLOWAY, Peter, D.; Ladas & Parry, 26 West 61st Street, New York, NY 10023 et al. (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

[Continued on next page]

(54) Title: RAZOR BLADE TECHNOLOGY




(57) Abstract: A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

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DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *without international search report and to be republished upon receipt of that report*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

BNSDOCID: <WO 0164406A2 I >

RAZOR BLADE TECHNOLOGY

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond; amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591334; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and polytetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

Particular embodiments of the invention may include one or more of



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the following features. In particular embodiments, the hard coating material can be made of carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides, carbides, oxides or other ceramics. The hard coating layer can have a thickness less than 2,000 angstroms. The overcoat layer can be made of chromium or a chromium containing alloy compatible with polytetrafluoroethylene such as a chromium platinum alloy. The overcoat layer can be between 100 and 500 angstroms thick. The blade can include an interlayer between the substrate and the layer of hard coating. The interlayer can include niobium or a chromium containing material. The polytetrafluoroethylene can be Krytox LW1200 available from DuPont. The PTFE outer layer can be between 100 and 5000 angstroms thick.

In another aspect, the invention features, in general, making a razor blade by providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets, adding a layer of hard coating on the cutting edge, adding an overcoat layer of a chromium containing material on the layer of hard coating, and adding an outer layer of polytetrafluoroethylene coating over the overcoat layer.

Particular embodiments of the invention may include one or more of the following features. In particular embodiments the layers can be added by physical vapor deposition (i.e., sputtering) or by chemical vapor deposition. The chromium containing layer, preferably chromium, can be sputter deposited under conditions that result in a compressively stressed coating. The sputter deposition of chromium containing materials can include applying a DC bias to the target that is more negative than -50 volts, preferably more negative than -200 volts. Alternatively an appropriate RF bias scheme can be used to achieve an equivalent chromium layer.

Embodiments of the invention may include one or more of the following advantages. The use of a chromium containing overcoat layer provides improved adhesion of the polytetrafluorethylene outer layer to the hard coating layer. The razor blade has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves. Reduced tip rounding minimizes the increase in cutting force thereby maintaining excellent shaving performance. The razor blade has excellent shaving characteristics from the first shave onwards.

Other features and advantages of the invention will be apparent from

the following description of a particular embodiment and from the claims.

FIG. 1 is a vertical sectional view of a cutting edge portion of a razor blade.

FIG. 2 is a perspective view of a shaving razor including the FIG. 1 razor blade.

Referring to FIG. 1, there is shown razor blade 10 including substrate 12, interlayer 14, hard coating layer 16, overcoat layer 18, and outer layer 20. The substrate 12 is typically made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 22 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium containing material. A particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard coating layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides (e.g., boron nitride, niobium nitride or titanium nitride), carbides (e.g., silicon carbide), oxides (e.g., alumina, zirconia) or other ceramic materials. The carbon containing materials can be doped with other elements, such as tungsten, titanium or chromium by including these additives, for example in the target during application by sputtering. The materials can also incorporate hydrogen, e.g., hydrogenated DLC. Preferably coating layer 16 is made of diamond, amorphous diamond or DLC. A particular embodiment includes DLC less than 2,000 angstroms, preferably less than 1,000 angstroms. DLC layers and methods of deposition are described in U.S. Patent No. 5,232,568. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond.

Overcoat layer 18 is used to reduce the tip rounding of the hard

coated edge and to facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 18 is preferably made of chromium containing material, e.g., chromium or chromium alloys that are compatible with polytetrafluoroethylene, e.g., CrPt. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer.

Outer layer 20 is used to provide reduced friction and includes polytetrafluoroethylene and is sometimes referred to as a telomer. A particular polytetrafluoroethylene material is Krytox LW 1200 available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a niobium interlayer 14, DLC hard coating layer 16, chromium overcoat layer 18, and Krytox LW1200 polytetrafluoroethylene outer coat layer 20. Chromium overcoat layer 18 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased negative bias is believed to promote a compressive stress (as opposed to a tensile stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200 - 400 angstroms, measured by SEM after application of overcoat layer 18 and before adding outer layer 20.

Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

In use, razor blade 10 has excellent shaving characteristics from the first shave onwards. Blade 10 has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves provided by the overlayer coating while maintaining excellent shave characteristics.

Other embodiments of the invention are within the scope of the appended claims.



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CLAIMS

1. A razor blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. The blade of claim 1, wherein said hard coating is made of a carbon containing material.

3. The blade of claim 2, wherein said carbon containing material comprises diamond.

4. The blade of claim 2, wherein said hard carbon coating comprises diamond-like carbon material.

5. The blade of claim 2, wherein said hard carbon coating comprises amorphous diamond material.

6. The blade of claim 1, wherein said overcoat layer consists of chromium.

7. The blade of claim 1, wherein said overcoat layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

8. The blade of claim 4, wherein said overcoat layer consists of chromium.

9. The blade of claim 7, wherein said alloy is a chromium platinum alloy.

10. The blade of claim 1, further comprising an interlayer between said substrate and said layer of hard carbon coating.

11. The blade of claim 10, wherein said interlayer comprises niobium.

12. The blade of claim 10, wherein said interlayer comprises a chromium containing material.

13. The blade of claim 6, 7, 8, or 9, wherein said overcoat layer is compressively stressed.

14. The blade of claim 1, wherein said polytetrafluoroethylene is Krytox LW1200.

15. The blade of claim 4, further comprising a niobium interlayer between said substrate and said hard coating.

16. The blade of claim 8, wherein said polytetrafluoroethylene is Krytox LW1200.

17. The blade of claim 1, wherein said hard coating layer has a thickness less than 2,000 angstroms.

18. The blade of claim 1, wherein said overcoat layer is between 100 and 500 angstroms thick.

19. The blade of claim 1, wherein said outer layer is between 100 and 5,000 angstroms thick.

20. The blade of claim 1, 8, 16 or 17, wherein said blade has a cutting edge that has less rounding with repeated shaves than it would have without said overcoat layer.

21. A shaving razor comprising:

a handle,

a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising:

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. The razor of claim 21, wherein said hard coating is made of a carbon containing material.

23. The razor of claim 22, further comprising a niobium interlayer between said substrate and said hard coating.

24. The razor of claim 21 or 22, wherein said overcoat layer consists of

chromium.

25. A method of making a razor blade comprising:

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

26. The method of claim 25, wherein said adding a layer of hard coating includes vapor depositing a carbon containing material.

27. The method of claim 25, wherein said adding a layer of chromium containing material includes vapor depositing said chromium containing material.

28. The method of claim 27, wherein said adding a layer of chromium containing material includes sputter depositing under conditions to result in compressively stressed material.

29. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -50 volts or an equivalent RF bias scheme.

30. The method of claim 28, wherein said sputtering includes applying a DC bias to said target that is more negative than -200 volts or an equivalent RF bias scheme.

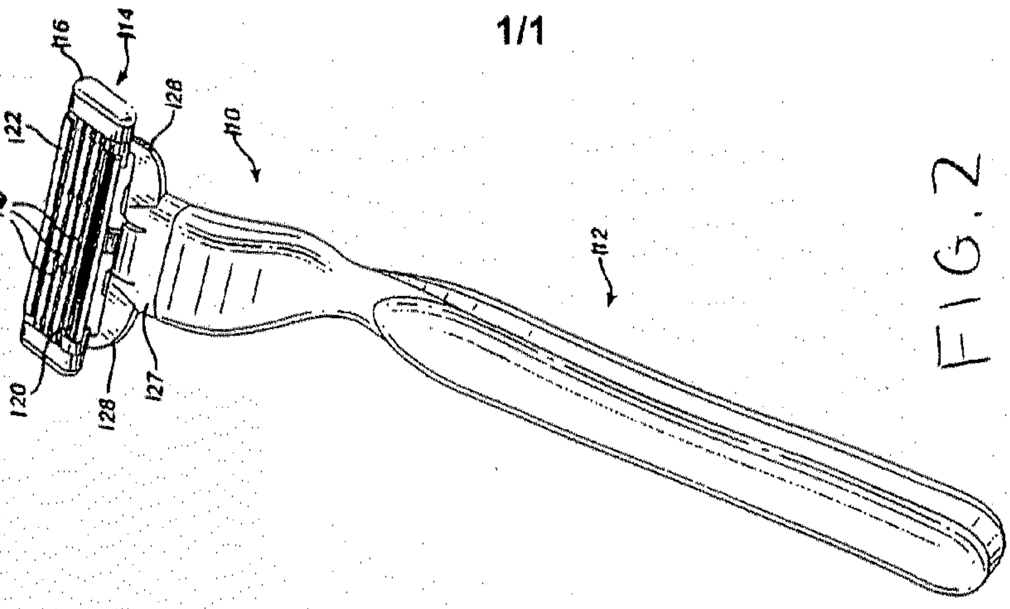


FIG. 2

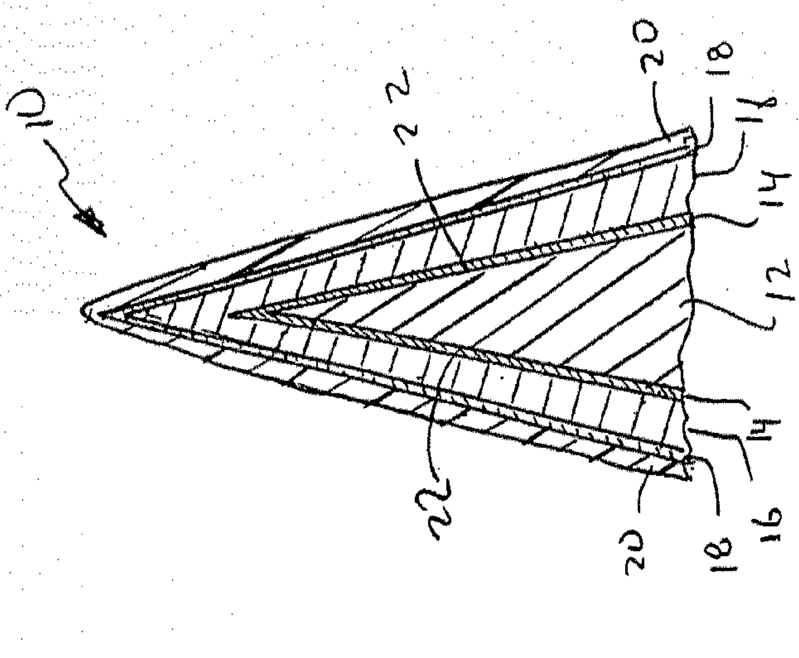


FIG. 1

BNSDOCID: <WO_____0164406A2_I_>

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/64406 A3

(51) International Patent Classification[7]: B26B 21/60

(21) International Application Number: PCT/US01/06206

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,421 29 February 2000 (29.02.2000) US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/515,421 (CON)
Filed on 29 February 2000 (29.02.2000)

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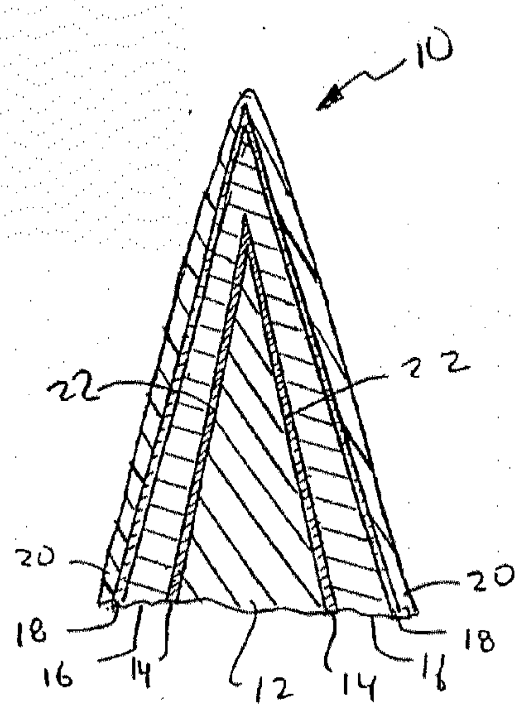
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,

[Continued on next page]

(54) Title: RAZOR BLADE TECHNOLOGY




(57) Abstract: A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

WO 01/64406 A3

DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *with international search report*

(88) **Date of publication of the international search report:** 7 February 2002

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/06206

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26B21/60

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Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

| | | |
|---|---|---|
| (51) International Patent Classification 4 : C23C 14/34 | A1 | (11) International Publication Number: WO 87/04471<br>(43) International Publication Date: 30 July 1987 (30.07.87) |

(21) International Application Number: PCT/US87/00162

(22) International Filing Date: 20 January 1987 (20.01.87)

(31) Priority Application Number: 8600829

(32) Priority Date: 23 January 1986 (23.01.86)

(33) Priority Country: GB

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(74) Agents: HANDELMAN, Joseph, H. et al.; Ladas & Parry, 26 West 61 Street, New York, NY 10023 (US).

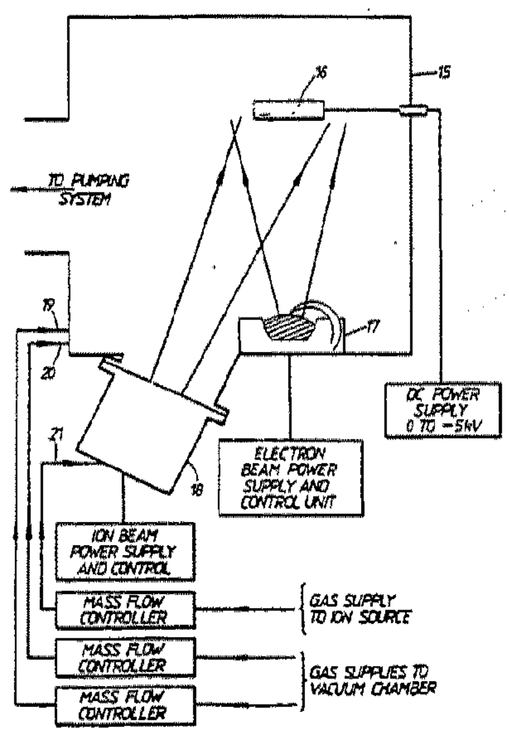
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), SE (European patent), US.

**Published**
*With international search report.*

(54) Title: FORMATION OF HARD COATINGS ON CUTTING EDGES

(57) Abstract

A method of making a cutting edge, which comprises coating a substrate cutting edge (16) having a defined cross-sectional geometry, with a material which is harder than the material of the substrate cutting edge (16) by a vapour deposition or sputtering process, if necessary in the presence of gaseous or vaporized molecules of another element or a compound of another element where it is desired to form the coating of a compound, at a pressure of less than $10^{-2}$m bar, while simultaneously subjecting the cutting edge (16) to ion bombardment with ions of sufficient mass and energy to cause sputter removal of the deposited material at a rate which is less than the rate of deposition, whereby a cutting edge formed of the deposited material and having a defined cross-sectional geometry and ultimate tip radius, is obtained.




BNSDOCID: <WO_______8704471A1_I_>

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FORMATION OF HARD COATINGS ON CUTTING EDGES

This invention is concerned with the formation of hard coatings on cutting edges, particularly those of razor blades, and with the coated cutting edges so obtained.

Theoretical studies and experimental work carried out by us have shown that the shaving performance of razor blades would be significantly improved if the thickness of the cutting edge over a distance back from the ultimate tip was substantially less than that of currently available razor blades. (For the avoidance of doubt the term "cutting edge" is used in this specification to refer to the whole marginal zone of a razor blade which is bounded by tapering surfaces or, in everyday parlance, is sharpened, while "ultimate tip" is used to refer to the final edge or tip of the razor blade; in conventional razor blades, the cutting edge extends some 400-450 µm back from the ultimate tip). The minimum thickness of the cutting edge for up to 25 µm back from the ultimate tip is determined by the nature of the blade material. For the steels which are currently used, the blade needs to be at least 0.7 µm thick at a distance of 1 µm from the blade tip in order to have sufficient strength to avoid unacceptable levels of shaving damage. On the other hand, if this part of the blade were formed of titanium carbide the blade would only need to be about 0.5 µm thick at a distance of 1 µm from the blade tip,

or if formed of boron nitride, only about 0.3 µm thick.

We have determined that in the case of stainless steel razor blades, the improvement in shaving performance referred to above is obtained if the cross-sectional shape of the cutting edge up to a distance of 40 µm from the ultimate tip is defined by the equation:

$$w = ad^n$$

where w is the tip width in µm of the cutting edge at a distance d in µm from the ultimate tip, a is a factor of proportionality of greater than 0 and up to 1 and n is an exponent having a value in the range 0.65 to 0.75. Razor blades having cutting edges of this character are described in our British Specification 2130955A. It is stated in that specification that blades made from or coated with materials harder than stainless steel, such as sapphire, titanium carbide or diamond, can be substantially thinner than stainless steel blades and modified formulae for the cross-sectional shapes of the cutting edges of such blades are given.

Specification 2130955A describes the formation of the cutting edge shapes therein described in stainless steel razor blades, but does not describe the manufacture of the thinner cutting edges which are obtainable with harder materials. The present invention is concerned with a method of forming such cutting edges by coating a pre-existing cutting edge (the substrate cutting edge) formed of steel or another material with a material harder, that is a material having a greater yield strength, or fracture strength, as appropriate for a more brittle material, than the material of the substrate cutting edge.

According to the present invention there is provided a method of making a cutting edge, which comprises coating the substrate cutting edge having a



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suitable cross-sectional geometry which is such that:

$$w \leq ad^n$$

where w is the tip width in µm of the cutting edge at a distance d in µm from the ultimate tip, a is a factor of proportionality of greater than 0 and up to 1 whose value is characteristic of the particular material of the substrate, and n is an exponent having a value in the range 0.65 to 0.75, with a material which is harder (i.e. has a higher yield strength) than the material of the substrate cutting edge by a vapor deposition or sputtering process, if necessary in the presence of gaseous or vaporized molecules of another element or a compound of another element where it is desired to form the coating of a compound, at a pressure of less than $10^{-2}$m bar, while simultaneously subjecting the cutting edge to ion bombardment with ions of sufficient mass and energy to cause sputter removal of the deposited material at a rate which is less than the rate of deposition, whereby a cutting edge formed of the deposited material and having a cross-sectional geometry defined by the equation:

$$ad^n \geq w \geq \frac{1}{\sqrt{m}} ad^n$$

and

$$w^3 \geq (w-2f)a^2d^{2n}$$

where w, d, a and n have the above-stated meanings, m is the ratio of the yield strength of the deposited coating material to that of the substrate material, and f is the thickness in µm of the deposited coating at the distance d from the ultimate tip, and an ultimate tip radius of less than 500 Å is obtained.

In the following description, reference will be made to the accompanying drawings, in which:

Figure 1 is a cross-section of a range of embodiments of coated cutting edges for a particular substrate and a coating material about four times as hard as the substrate material, obtained by the method



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of the invention;

Figure 2 is a diagrammatic representation generally similar to Figure 1 illustrating a particular feature of the invention; and

Figure 3 is a diagrammatic representation of preferred apparatus for carrying out the method according to the invention.

The general form of a coated cutting edge obtained by the method of the invention is shown in Figure 1; this shows a substrate cutting edge 10 and a coating of the harder material 11 which is approximately four times as hard as the substrate material. A combination of substrate material and coating material meeting this requirement is, for example, steel/TiN. The range of thicknesses of the coating material 11 within the scope of the invention, for the particular substrate cutting edge 10 shown, is indicated by the shaded area 12. Typical dimensions of the portion of the coated cutting edge adjacent the ultimate tip are indicated by the scale on the left hand side of the Figure which is in micrometers.

It would be understood that the geometry of the coated cutting edge and the range of thicknesses of the coating material would be different for other combinations of substrate material and coating material, that is combinations in which the ratio of the hardness of the coating material to that of the substrate material is other than four.

We have stated above that the substrate cutting edge should have a suitable cross-sectional geometry which is such that w is equal to or less than $ad^n$. The obtaining of a product coated cutting edge which has the desired cross-sectional geometry (that is as defined by the above formulae and by the specified ultimate tip radius) is dependent not only on the process conditions used, but also on the use of appropriate substrate cutting edges and coating

materials. For a given substrate material and geometry, the harder the coating material, the narrower will be the final cross-sectional geometry. The preferred geometry of the coated cutting edge, with a given coating, is that with the narrowest possible tip cross-section; it follows that this will be achieved using the hardest coating material deposited in the thickest possible form within the constraints imposed by the equations set out above.

In order to obtain the desired geometry of the final coated cutting edge, we have found that it is necessary for the coating to have an aspect ratio of from 1 to 10, preferably from 2 to 8, the aspect ratio being the thickness of the coating on the ultimate tip of the substrate, T, divided by the thickness of the coating on the facets of the cutting edge, F, that is T/F. For example, the aspect ratio of the coating shown in Figure 1 ranges from 4.5 for the thickest coating 11 to 7.8 for the thinnest.

To obtain such an aspect ratio it is necessary that the molecular species which are deposited on the substrate cutting edge should be directed at it along paths which are parallel to the central plane of the substrate as shown in Figure 2 in which the central plane of the substrate is indicated at 13 and the paths of the deposited molecular species at 14. This type of deposition may be referred to as "line of sight" deposition. It can only be obtained if the mean free path of the depositing molecules in the deposition chamber, that is the average distance they travel before one such molecule collides with another is greater than the distance between their source and the substrate to be coated. This in term requires that the deposition be carried out at a pressure which is sufficiently low to obtain a sufficiently large mean free path. For the deposition procedures and apparatus suitable for carrying out the



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method of the invention, this means, in practice, that the method of the invention must be carried out at a pressure of less than $10^{-2}$m bar, preferably less than $10^{-3}$m bar.

Preferred apparatus for carrying out the method according to the invention is shown diagrammatically in Figure 3. The apparatus comprises a sealable vacuum chamber 15 connected to a vacuum pumping system (not shown) which is capable of pumping down to the necessary low pressure. The chamber contains a holder 16 for the substrate razor blades which preferably takes the form of a water cooled knife. The holder 16 is electrically connected to a DC power supply which can be adjusted from 0 to -5kV so as to provide negative bias. Within the chamber 15 is an electron beam evaporator 17 for generating a supply of vaporized coating material (or a constituent part of the coating material where the coating is a compound) and an ion source 18 for the bombarding ions.

The vacuum chamber 15 is provided with gas inlets 19 and 20 and the ion source is provided with a gas inlet 21 whereby the chamber and the ion source may be separately supplied with desired gases. Each of the gas supplies is separately controlled by a mass flow controller. This arrangement enables the chamber pressure and the gas composition to be very precisely controlled.

The electron beam evaporator and the ion source may be any suitable commercially available unit.

Although it is preferred to vaporize the coating material (or a constituent thereof) by electron beam evaporation, this is not the only way such vaporization may be effected. Other procedures that may be used include, for example, any other form of thermal evaporation or sputtering. The use of any such other procedures will, of course, require suit-

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able modification of the apparatus.

The bombarding ions used in the method of the invention may be inert to the deposited material or reactive therewith, the former normally being preferred. The current density of the ion bombardment must cause a suitable rate of sputter removal from the deposit, that is a rate of removal which is less than the rate of deposition (so that there is net deposition), but which is sufficient to obtain the desired shape in the final coated cutting edge.

A further important function of the ion bombardment is to refine the microstructure of the deposited material. In the absence of such ion bombardment, certain deposited materials are laid down with a columnar microstructure which is inherently weak so that the coating tends to fracture along the grain boundaries adjacent to the tip of the substrate cutting edge. The use of the ion bombardment simultaneously with deposition of the coating prevents this undesirable microstructure being formed.

The mass and energy requirements of ion bombardment to ensure such refining of the microstructure are generally less than those required of the ion bombardment in order to obtain the desired shape of the coated cutting edge so that if the latter requirement is met, it can generally be taken that the former requirement will be met.

In the light of the foregoing it will be apparent that suitable current densities for the ion bombardment will depend on the mass of the bombarding ions and the nature of the deposited material and numerical limits cannot, therefore, be stated.

The power density of the ion bombardment should not be so high that thermal degradation of the substrate material, in particular the yield strength of the latter, takes place, but should, in principle, be as high as possible subject to this limitation so

that processing time is minimized.

It is generally preferred to use inert gas ions, more preferably argon ions, as the bombarding ions, but other ions which can be used include, for example, nitrogen and oxygen.

The substrate cutting edge is preferably formed of steel, preferably stainless steel, but other materials that may be used include, for example, other refractory metals and their alloys, ceramics, glasses and polymers.

Suitable coating materials include, for example, metal oxides, nitrides, carbides and borides, and mixtures of a metal and an oxide, nitride or carbide thereof. Preferred coating materials include, for example, alumina (sapphire), tungsten carbide, titanium nitride, boron nitride, and mixtures of boron and boron nitride.

Nitride coatings, for example TiN and BN, are preferably formed by electron beam evaporation or sputtering of the metal, for example titanium or boron, with nitrogen present in the deposition chamber in an amount required for the coating to be formed of the desired metal nitride. Coatings consisting of a mixture of such a nitride and the corresponding metal, such as a coating of boron containing 10% by weight of boron nitride, are also of interest. These coatings may be obtained by restricting the amount of nitrogen present in the chamber to that required to give the desired conversion of the deposited metal to its nitride.

The boron/boron nitride mixture referred to above has a Vickers hardness of 4200 kg/mm$^2$ and is thus considerably harder than titanium nitride which has a Vickers hardness of 2000 kg/mm$^2$.

Carbide coatings, for example TiC, are preferably formed in a similar way, but with a vaporized hydrocarbon present in place of nitrogen,



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the amount of hydrocarbon being sufficient to provide the amount of carbon to form the desired carbide.

Oxide coatings, for example $Al_2O_3$, are preferably evaporated directly, but may be formed in a similar way, but with oxygen present in place of nitrogen and the amount of oxygen being sufficient to provide the amount required to form the desired oxide.

A further coating material which may be used is diamond-like carbon (DLC), but the formation of coatings of this material requires some modification of the method according to the invention. Since this material consist of carbon alone, it is not necessary to vaporize the coating material by one or other of the procedures described above and it is only necessary to introduce a gaseous or vaporized hydrocarbon directly into the vacuum chamber or via the ion source. Suitable hydrocarbons include, for example, methane, butane, propane and acetylene. The ion bombardment is, of course, carried out as described for other coating materials. In addition an RF glow discharge may be used in the deposition chamber to form the diamond-like carbon while simultaneously bombarding with an ion beam.

Although we have referred above to coatings formed of single compounds or mixtures, coatings of two or more different materials (that is, multilayer coatings) may be formed by the method according to the invention. The formation of coatings in two more layers is primarily of interest when the outer or final coating does not have the desired adhesion to the substrate cutting edge. In such cases, a first coating is formed of a material which has good adhesion to the substrate and to which the desired outer coating has good adhesion, and the outer coating is then formed. By way of example, the boron/boron nitride mixture referred to above has much better adhesion to the substrate when the latter is first



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coated with titanium nitride then when the boron/boron nitride mixture is coated directly on to the stainless steel. A further example is the improved adhesion of diamond-like carbon when deposited with an interlayer of a metal such as chromium or titanium.

In order that the invention may be more fully understood, the following examples are given by way of illustration only:

EXAMPLE

The apparatus used was as described above with reference to Figure 3. The electron beam evaporator was a 10 kW Electrotech ET15 unit and the ion source was a 2.5 cm Kaufman Ion Source. The substrate holder was positioned 300 mm above the ion source. At this distance from the source, the beam had a diameter of 100 mm allowing a maximum current density of 1.25 $mA/cm^2$. The energy of the ions could be varied up to 1.5 kV at the ion source and, in addition, the substrate holder could be negatively biased to -5 kV giving an overall range of ion energy from 0 to 6.5 kV.

The substrate blades were stainless steel blades having pre-formed cutting edges having a tip width complying with the formula $w < ad^n$, where a is the factor of proportionality appropriate to stainless steel, i.e. about 0.7.

Titanium nitride coatings were formed on the cutting edges of these blades by evaporating titanium in the electron beam evaporator with sufficient nitrogen present in the chamber so that the deposited coating was formed entirely of titanium nitride. The bombarding ions were argon and the pressure in the chamber was $9 \times 10^{-4}$m bar.

A series of runs was carried out using a constant bombarding ion energy of 1.5 kV and with a constant beam current of 50 mA, giving a current density of 0.4 $mA/cm^2$, but using substrate bias



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voltages as follows:

| | |
|---|---|
| Run A | 0 |
| Run B | 1.5 kV |
| Run C | 2.5 kV |
| Run D | 4.0 1V |

The tip dimensions were measured on the coated blades using the technique described in our Specification 2130955A, and the coating thickness determined from photomicrographs of the cutting edge after it had been fractured in cross-section to show the form of the coating. From all these measurements, values of a, n, and f were calculated and the results examined to ascertain whether or not the shape criteria for the coated edge had been achieved, as follows:

| | Tip: facet aspect ratio between 1 and 10 | $w \leqslant ad^n$ | $w \geqslant \frac{1}{\sqrt{m}} ad^n$ | $w^3 \geqslant (w-2f)a^2d^{2n}$ |
|---|---|---|---|---|
| Run A | Yes | No | Yes | Yes |
| Run B | Yes | No | Yes | Yes |
| Run C | Yes | No | Yes | Yes |
| Run D | Yes | Yes | Yes | Yes |

From these results, Runs A, B and C produced blades which were not in accordance with the invention; the coated blades from Run D were in accordance with the invention.



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PACE-037415

C L A I M S

1. A method of making a cutting edge, which comprises coating a substrate cutting edge having a suitable cross-section geometry which is such that:

$$w \leq ad^n$$

where w is the tip width in µm of the cutting edge at a distance d in µm from the ultimate tip, a is a factor of proportionality of greater than 0 and up to 1, and n is an exponent having a value in the range 0.65 to 0.75, with a material which is harder than the material of the substrate cutting edge by a vapor deposition or sputtering process, if necessary in the presence of gaseous or vaporized molecules of another element or a compound of another element where it is desired to form the coating of a compound, at a pressure of less than $10^{-2}$m bar, while simultaneously subjecting the cutting edge to ion bombardment with ions of sufficient mass and energy to cause sputter removal of the deposited material at a rate which is less than the rate of deposition, whereby a cutting edge formed of the deposited material and having a cross-sectional geometry defined by the equations:

$$ad^n \geq w \geq \frac{1}{\sqrt{m}} ad^n$$

and

$$w^3 \geq (w-2f)a^2d^{2n}$$

where w, d, a and n have the above-stated meanings, m is the ratio of the yield strength of the deposited coating material to that of the substrate material, and f is the thickness in µm of the deposited coating at the distance d from the ultimate tip, and an ultimate tip radius of less than 500 Å, is obtained.

2. A method according to claim 1, in which the pressure is less than $10^{-3}$m bar.

3. A method according to claim 1 or 2, in which ion bombardment is effected with inert gas ions.

4. A method according to any of claims 1 to 3, in which the coating is formed of a metal oxide, nitride, carbide or boride, of a mixture of a metal and an oxide, nitride or

carbide thereof, or of diamond-like carbon.

5. A method according to claim 4, in which the coating is formed of alumina, tungsten carbide, titanium nitride, boron nitride, or a mixture of boron and boron nitride.

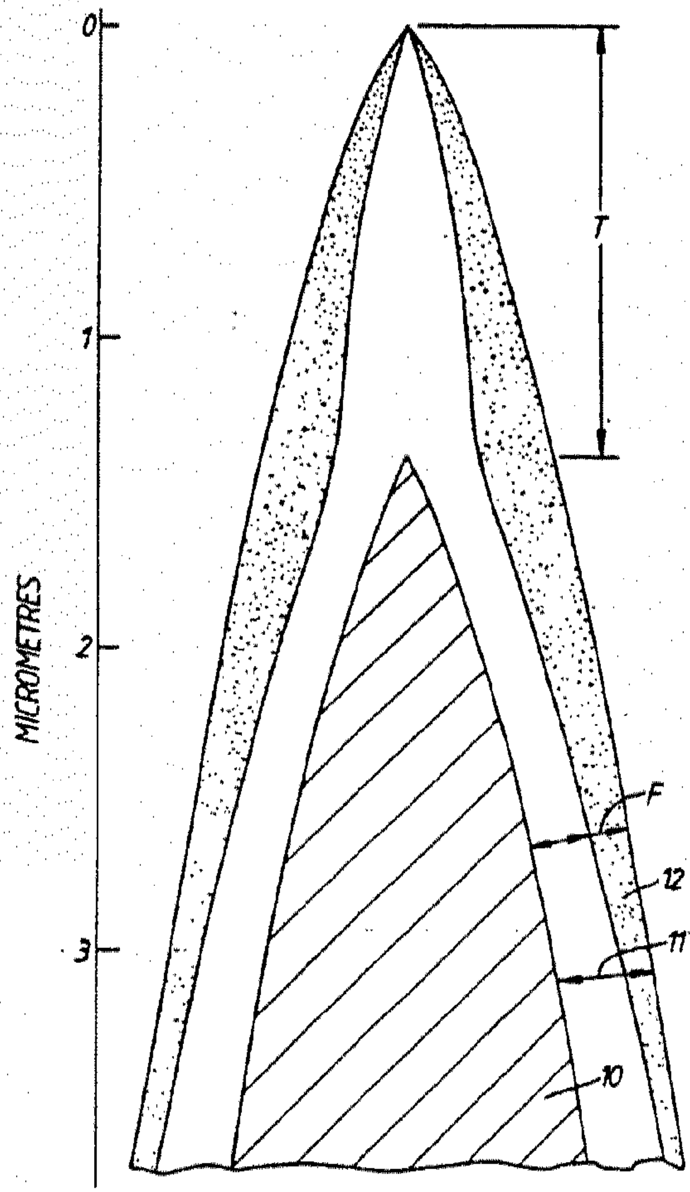


FIG. 1.

SUBSTITUTE SHEET

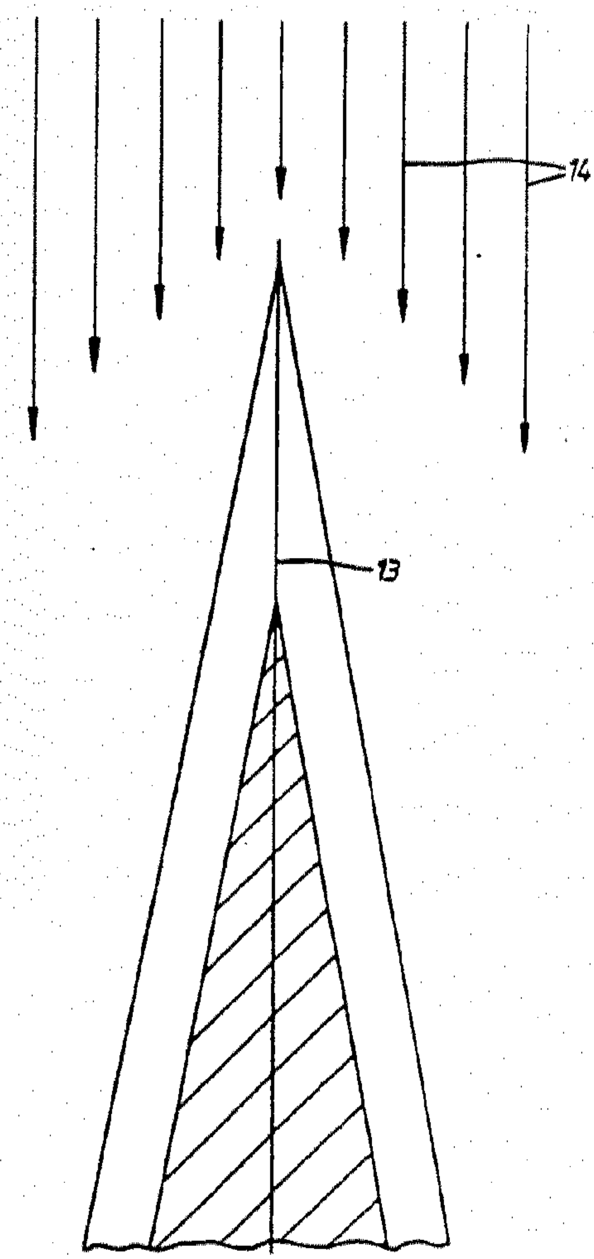


FIG. 2.

SUBSTITUTE SHEET

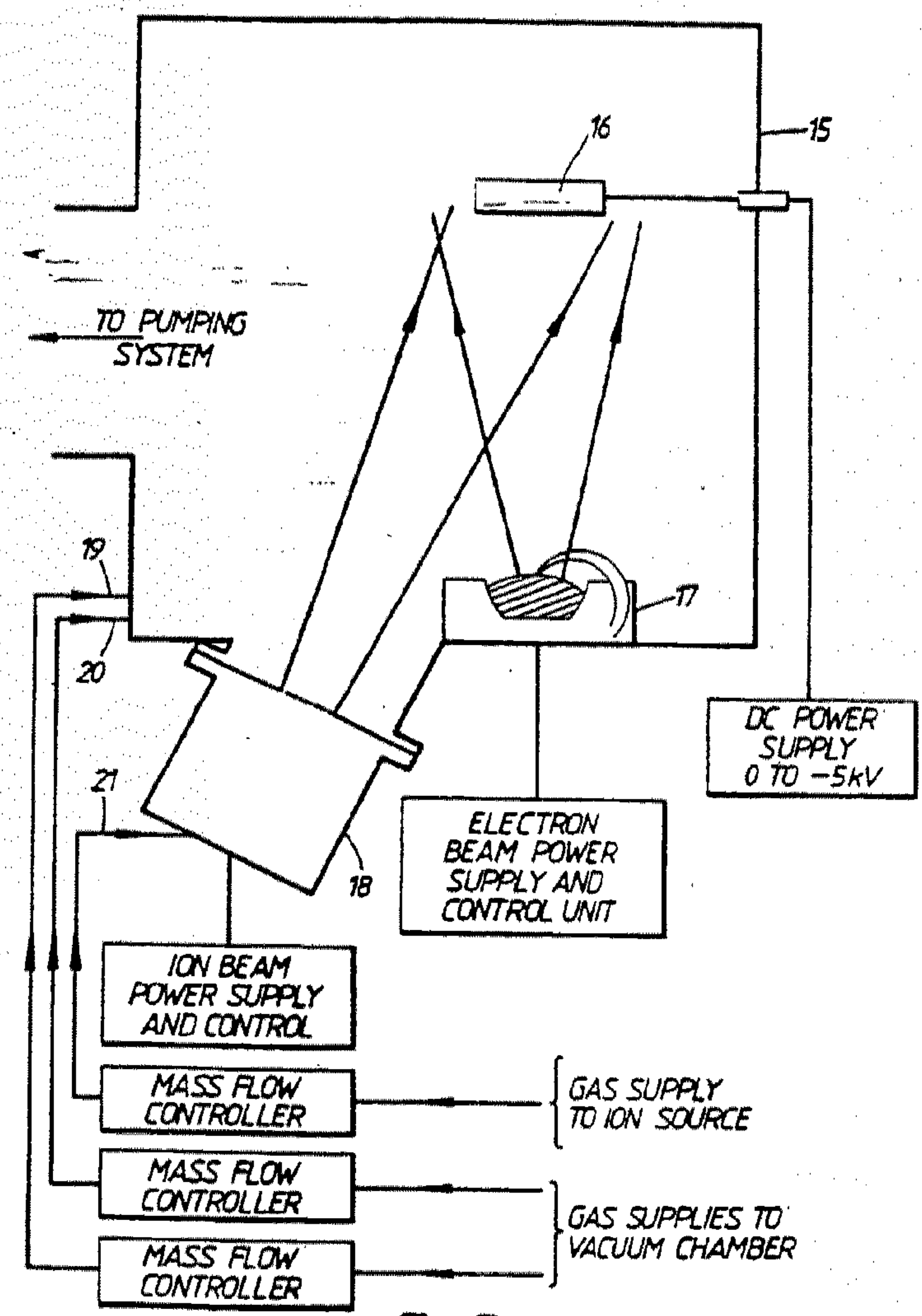


FIG. 3.



PACE-037420

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/00162

**I. CLASSIFICATION OF SUBJECT MATTER** (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL[4]: C23C 14/34
U.S. CL. 204/192.12

**II. FIELDS SEARCHED**

Minimum Documentation Searched [4]

| Classification System | Classification Symbols |
|---|---|
| U.S. | 204/192.11, 192.12, 192.15, 192.16, 192.22, 192.32, 427/38, 298 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

**III. DOCUMENTS CONSIDERED TO BE RELEVANT** [14]

| Category * | Citation of Document, [16] with indication, where appropriate, of the relevant passages [17] | Relevant to Claim No. [18] |
|---|---|---|
| X | U.S., A, 3,652,443 (FISH ET AL) 28 MARCH 1972, see column 2, lines 30-33, column 3, lines 47-49, column 4, lines 14-16. | 1-3 |
| X | U.S., A, 3,740,327 (LANE ET AL) 19 JUNE 1973, see column 6, lines 13-41, examples 1-5. | 1-3 |
| X | U.S., A, 3,761,374 (BROMER ET AL) 25 SEPTEMBER 1973, see figures 1-3, column 2, lines 1-46. | 1-3 |
| X | U.S., A, 3,802,078 (DENES) 09 APRIL 1974, see figures 1 and 3, column 2, lines 22-28, Table I, column 6, lines 3-17. | 1-5 |
| X | U.S., A, 3,829,969 (FISCHBEIN ET AL) 20 AUGUST 1974, see column 3, lines 6-30, column 6, lines 3-9. | 1-3 |
| X | U.S., A, 3,911,579 (LANE ET AL) 14 OCTOBER 1975, see figures 1 and 5, column 5, lines 55-65, examples 1-3.* | 1-5 |

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

**IV. CERTIFICATION**

| Date of the Actual Completion of the International Search [2] | Date of Mailing of this International Search Report [2] |
|---|---|
| 01 APRIL 1987 | 14 APR 1987 |
| **International Searching Authority [1]** | **Signature of Authorized Officer [10]** |
| ISA/US | H. NGUYEN |

Form PCT/ISA/210 (second sheet) (May 1986)

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PACE-037421

OIPE JC173
SEP 1 6 2004
PATENT & TRADEMARK OFFICE

3724
Attorney's Docket No.: 00216-607001 / Case 8104

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | | |
|---|---|---|---|
| Applicant | : Colin Clipstone et al. | Art Unit | : 3724 |
| Serial No. | : 10/379,264 | Examiner | : Stephen Choi |
| Filed | : March 4, 2003 | | |
| Title | : RAZOR BLADE | | |

**Mail Stop Amendment**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT IN REPLY TO ACTION OF JULY 1, 2004

Please amend the above-identified application as follows:

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

September 14, 2004
Date of Deposit

Sherry L. Hunt
Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Cancelled).

2. (Currently Amended) A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond, doped with chromium or an alloy of chromium, on the cutting edge, the coating including from 0.1 to 10 atomic percent chromium; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating consisting of [[a]] the carbon-containing material and the cutting edge.

3. (Cancelled).

4. (Currently Amended) The razor blade of claim 2, wherein the coating consisting of [[a]] the carbon-containing material includes from 1 to 5 atomic percent chromium.

5. (Currently Amended) The razor blade of claim 2, wherein the ~~coating of a~~ carbon-containing material is diamond-like carbon.

6. (Currently Amended) The razor blade of claim 2, wherein the ~~coating of a~~ carbon-containing material ~~is selected from the group consisting of diamond and~~ amphorous diamond.

7.-8. (Cancelled).

9. (Currently Amended) The razor blade of claim 2, further comprising an overcoat layer between the coating consisting of [[a]] the carbon-containing material and the coating of polytetrafluoroethylene.

10. (Original) The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. (Currently Amended) The razor blade of claim 2, wherein the coating consisting of [[a]] the carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. (Cancelled).

13. (Currently Amended A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond doped with chromium or an alloy of chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14.-21. (Cancelled).

22. (New) The shaving razor of claim 13, wherein the coating consisting of a carbon-containing material includes from 1 to 5 atomic percent chromium.

23. (New) The shaving razor of claim 13, wherein the carbon-containing material is diamond-like carbon.

24. (New) The shaving razor of claim 13, wherein the carbon-containing material is amphorous diamond.

## REMARKS

Applicants filed a preliminary amendment and an Information Disclosure Statement (with Form 1449) on June 23, 2004. The Examiner acknowledged neither in the July 1, 2004 office action. Applicants will assume the preliminary amendment has been entered and request an initialed copy of the Form 1449.

Claims 2 and 13 as amended require a coating consisting of diamond-like carbon ("DLC"), diamond, or amphorous diamond doped with chromium or an alloy of chromium. There is no interlayer between the coating and blade. The language "consisting of" is closed, which means the coating consists only of the DLC, diamond, or amphorous diamond and the chromium. This is the structure of the specific embodiment of hard carbon layers described in the specification.

Claims 2-6, 11, and 13 were rejected under 35 U.S.C. § 102(b) as anticipated by Goel et al., U.S. Pat. 5,795,658 ("Goel"). Goel discloses a substrate with a diamond-like nanocomposite ("DLN") coating. The DLN coating includes a carbon material and a glass-like silica network. Goel calls this a "two-component network". See, e.g., col. 4, lines 25-31 and 63-66. That network may further be doped with a dopant network to provide a three-component network. See col. 4, line 41 - col. 5, line 6. In any event, the coating never consists of the combination of a hard carbon material and a metal dopant alone; the silica network is a fundamental part of the DLN coating. Thus, Goel does not anticipate claims 2-6, 11, and 13 because the DLN coating will always include the silica network. Moreover, because Goel teaches that the silica network is a crucial component of the DLN coating, a person of ordinary skill in the art would not be motivated to remove such a crucial component from the DLN coating.

The secondary reference, Clipstone et al., U .S. Pat. 6,684,513, cited in combination with Goel as the basis for rejecting claims 9 and 10 under 35 U.S.C. § 103(a) adds nothing of significance to the above analysis. Thus, claims 9 and 10 are patentable for at least the reasons discussed above.

Applicants submit that the claims are in condition for allowance and such action is requested.

Please apply any other charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: September 14, 2004

Robert C. Nabinger
Reg. No. 33,431

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# PATENT APPLICATION FEE DETERMINATION RECORD
Effective January 1, 2003

Application or Docket Number: 10,379264

## CLAIMS AS FILED - PART I

| | (Column 1) | (Column 2) |
|---|---|---|
| TOTAL CLAIMS | 21 | |
| FOR | NUMBER FILED | NUMBER EXTRA |
| TOTAL CHARGEABLE CLAIMS | 26 minus 20= | * 6 |
| INDEPENDENT CLAIMS | 6 minus 3 = | * 3 |
| MULTIPLE DEPENDENT CLAIM PRESENT | | ☐ |

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

| RATE | FEE | | RATE | FEE |
|---|---|---|---|---|
| BASIC FEE | $375 | OR | BASIC FEE | $750 |
| X$ 9= | | OR | X$18= | 108 |
| X42= | | OR | X84= | 252 |
| +140= | | OR | +280= | 280 |
| TOTAL | | OR | TOTAL | 139[illegible] |

## CLAIMS AS AMENDED - PART II

9/16/04

### AMENDMENT A

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * 11 | Minus | ** 26 | = |
| Independent | * 2 | Minus | *** 6 | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ |

SMALL ENTITY OR OTHER THAN SMALL ENTITY

| RATE | ADDITIONAL FEE | | RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT B

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ |

| RATE | ADDITIONAL FEE | | RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT C

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA |
|---|---|---|---|---|
| Total | * | Minus | ** | = |
| Independent | * | Minus | *** | = |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ |

| RATE | ADDITIONAL FEE | | RATE | ADDITIONAL FEE |
|---|---|---|---|---|
| X$ 9= | | OR | X$18= | |
| X42= | | OR | X84= | |
| +140= | | OR | +280= | |
| TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 1/03)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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# PATENT APPLICATION FEE DETERMINATION RECORD
Effective January 1, 2003

Application or Docket Number: 10,379264

## CLAIMS AS FILED - PART I

| | (Column 1) | (Column 2) | SMALL ENTITY TYPE RATE | FEE | OR | OTHER THAN SMALL ENTITY RATE | FEE |
|---|---|---|---|---|---|---|---|
| TOTAL CLAIMS | 21 | | | | | | |
| FOR | NUMBER FILED | NUMBER EXTRA | BASIC FEE | $375 | OR | BASIC FEE | $750 |
| TOTAL CHARGEABLE CLAIMS | 26 minus 20= | * 6 | X$ 9= | | OR | X$18= | 108 |
| INDEPENDENT CLAIMS | 6 minus 3 = | * 3 | X42= | | OR | X84= | 252 |
| MULTIPLE DEPENDENT CLAIM PRESENT | | | +140= | | OR | +280= | 280 |
| | | | TOTAL | | OR | TOTAL | 1390 |

* If the difference in column 1 is less than zero, enter "0" in column 2

## CLAIMS AS AMENDED - PART II

### AMENDMENT A

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | SMALL ENTITY RATE | ADDITIONAL FEE | OR | OTHER THAN SMALL ENTITY RATE | ADDITIONAL FEE |
|---|---|---|---|---|---|---|---|---|---|
| Total | * 9 | Minus | ** 26 | = | X$ 9= | | OR | X$18= | |
| Independent | * 2 | Minus | *** 6 | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT B

9/16/04

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | RATE | ADDITIONAL FEE | OR | RATE | ADDITIONAL FEE |
|---|---|---|---|---|---|---|---|---|---|
| Total | * 11 | Minus | ** 26 | = | X$ 9= | | OR | X$18= | |
| Independent | * 2 | Minus | *** 6 | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT C

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | RATE | ADDITIONAL FEE | OR | RATE | ADDITIONAL FEE |
|---|---|---|---|---|---|---|---|---|---|
| Total | * | Minus | ** | = | X$ 9= | | OR | X$18= | |
| Independent | * | Minus | *** | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

PACE-037428

OIPE JC19 OCT 08 2004 PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 00216-607001 / Case 8104

3724 IFW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## INFORMATION DISCLOSURE STATEMENT

A copy of the reference listed on the attached form PTO-1449 is enclosed.

Reference (AL) on the enclosed Form 1449 is the published PCT counterpart to Yamada et al., U.S. 2004/0099120 (reference AA on the Form 1449 filed on June 23, 2004). Reference (AL) published more than a year prior to the present application and qualifies as prior art under 35 U.S.C. § 102(b). The Examiner should use Yamada et al., U.S. 2004/0099120 as the English translation of reference AL on the enclosed Form 1449.

This statement is being filed after a first Office action on the merits, but before receipt of a final Office action or a Notice of Allowance. A check for $180 in payment of the late submission fee of §1.17(p) is enclosed. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: October 6, 2004

Robert C. Nabinger
Reg. No. 33,431

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225 Franklin Street
Boston, MA 02110-2804
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Facsimile: (617) 542-8906
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10/13/2004 HDEMESS1 00000003 10379264
01 FC:1806 180.00 OP

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I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

October 6, 2004
Date of Deposit

Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

OCT 0 8 2004 PATENT & TRADEMARK OFFICE



| | | |
|---|---|---|
| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

**U.S. Patent Documents**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
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**Foreign Patent Documents or Published Foreign Patent Applications**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| | AL | WO 01/94083 | 12/13/01 | PCT (English Abstract Only) | | | | X |
| | AM | | | | | | | |
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| | AP | | | | | | | |

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| Examiner Initial | Desig. ID | Document |
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| Examiner Signature | Date Considered |
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Substitute Disclosure Form (PTO-1449)

PACE-037430

(12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2001年12月13日 (13.12.2001)

PCT

(10) 国際公開番号
WO 01/94083 A1

(51) 国際特許分類⁷: B26B 21/60

(21) 国際出願番号: PCT/JP01/04696

(22) 国際出願日: 2001年6月4日 (04.06.2001)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願2000-167359 2000年6月5日 (05.06.2000) JP

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(81) 指定国 (国内): AE, AU, BR, CA, MX, NZ, US, ZA.

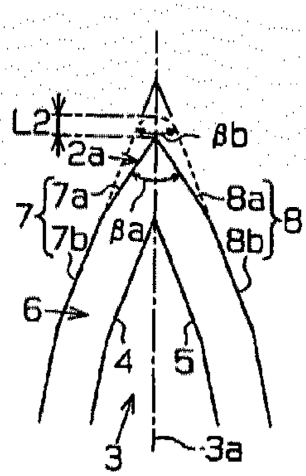
(84) 指定国 (広域): ヨーロッパ特許 (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

添付公開書類:
— 国際調査報告書

[続葉有]

(54) Title: CUTTING BLADE AND METHOD OF PRODUCING THE SAME

(54) 発明の名称: 刃及び刃の製造方法




(57) Abstract: A cutting blade (1) having improved sharpness and durability, comprising a base plate (3) having a blade tip (2), a coating (6) covering the blade tip, the coating being formed of a material containing metal, the tip (2a) of the coating being sharpened, wherein the angle (βa) between two inclined surfaces (7a, 8a) with the tip lying therebetween is preferably 15 - 45 degrees.

(57) 要約:

切れ味及び耐久性の向上された刃（１）が開示される。刃は刃先（２）を有する基板（３）と、刃先を覆う被覆層（６）とを有する。被覆層は金属を含む素材により形成され、被覆層の尖端（２ａ）は鋭利化加工されている。尖端を挟む２つの傾斜面（７ａ，８ａ）間の角度（βａ）は好ましくは１５～４５度である。

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２文字コード及び他の略語については、定期発行される各*PCT*ガゼットの巻頭に掲載されている「コードと略語のガイダンスノート」を参照。

# 明細書

刃及び刃の製造方法

## 技術分野

本発明は、刃に関し、詳しくは、刃先に被覆層を有する刃及びその刃の製造方法に関する。

## 背景技術

従来より、剃刀やミクロトームのような刃の切れ味を改善するために、刃先は種々の方法で加工される。例えば、刃の表面をクロム１００％の皮膜で被覆する加工がある。

## 発明の開示

本発明の目的は、切れ味が良く、向上された耐久性を有する刃を提供することにある。

上記の目的を達成するために、本発明の第１の態様によれば、刃先を有する基板と、前記基板の少なくとも刃先を覆う被覆層とから形成される刃が提供される。前記被覆層はＰｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ及びＣｒからなる群から選択された少なくとも一つの金属と炭素材料とを含有する混合層を含む。

本発明の第２の態様によれば、刃先を有する基板と、少なくとも前記刃先を覆う被覆層とを備える刃が提供される。前記被覆層はＰｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された炭素層とから形成されている。

本発明の第３の態様によれば、刃先を有する基板と、少なくとも前記刃先を覆う被覆層とを備える刃が提供される。前記被覆層はＰｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、

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Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された混合層であって、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する前記混合層とから形成されている。

本発明の第４の態様によれば、尖端に向かって小さくなるように形成された刃先を有する基板と、少なくとも前記刃先を覆う被覆層とを備える刃が提供される。前記被覆層は、前記刃先の尖端側において、当該被覆層を部分的に削除することにより形成され、かつ、当該尖端に向かって傾斜する少なくとも一つの傾斜面を有する。

本発明の第５の態様によれば、２つの表面により形成される刃先を有する基板を備える刃が提供される。前記刃先は、前記２つの表面の少なくとも一方を部分的に削除することにより形成された傾斜面を有する。

本発明の第６の態様によれば、２つの表面により形成される刃先を有する基板と、前記基板を覆う被覆層とを含む刃が提供される。前記基板は、その縁から前記２つの表面に沿ってそれぞれ延びる２つの第１内側傾斜面と、前記２つの第１内側傾斜面にそれぞれ連続して延びる２つの第２内側傾斜面とを有する。前記２つの第１内側傾斜面間の角度は、前記２つの第２内側傾斜面間の角度よりも大きい。被覆層は前記刃先の尖端において互いが接続される２つの第１外側傾斜面と、前記２つの第１外側傾斜面にそれぞれ連続して延びる２つの第２外側傾斜面とを有する。前記２つの第１外側傾斜面間の角度は、前記２つの第２外側傾斜面間の角度よりも大きい。

本発明の第７の態様によれば、刃の製造方法が提供される。その製造方法は、２つの面を有する基板を用意する工程と、前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成する工程と、前記基板の少なくとも前記縁を覆う被覆層を形成する工程と、前記被覆層を部分的に削除することにより、前記被覆層の前記縁に対応する位置から傾斜する、少なくとも一つ

の傾斜面を形成するする工程とを含む。

本発明の第８の態様によれば、刃の製造方法が提供される。その製造方法は、２つの面と、前記２つの面により区画される縁とを有する基板を用意する工程と、前記基板の少なくとも前記縁を覆う被覆層を形成する工程と、前記基板の２つの面に対応する前記被覆層の２つの表面のうち少なくとも一つを削除して傾斜面を形成する工程と、前記被覆層上に第２の被覆層を形成する工程とを含む。

本発明の第９の態様によれば、刃の製造方法が提供される。その製造方法は、２つの面を有する基板を用意する工程と、前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成する工程と、前記基板の２つの面のうち少なくとも一つを削除して傾斜面を形成する工程とを含む。

本発明の第１０の態様によれば、刃の製造方法が提供される。その製造方法は、２つの面を有する基板を用意する工程と、前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成する工程と、前記基板の２つの面のうち少なくとも一つを削除して傾斜面を形成する工程と、前記傾斜面を被覆する被覆層を形成する工程とを含む。

図面の簡単な説明

図１（ａ）～（ｆ）は本発明の第１実施形態にかかる図７の剃刀刃の刃先の模式的拡大図である。

図２～５は上記刃先を覆う被覆層の拡大断面図である。

図６（ａ）～６（ｃ）は図１（ｃ）及び１（ｄ）の工程の別例を示す。

図７は図１の剃刀刃を有する剃刀頭部の斜視図である。

図８（ａ）～（ｃ）は本発明の第２実施形態にかかる剃刀刃の刃先の模式的拡大図である。

図９は本発明の第３実施形態にかかる剃刀刃の刃先の模式的拡大図である。

発明を実施するための最良の形態

本発明の第１実施形態では、図７に示す剃刀に装着される刃１の製造方法、すなわち刃先２の加工方法が添付の図面を参照して説明される。

刃１は基板３から以下の工程で製造される。まず、第一工程において、基板３の研削により、傾斜した側面４，５が形成される。詳しくは、図１（ａ）に示すように、基板３の上端に向かって先細になるように、かつ、基板３の中央面３ａに対する角度が互いに等しくなるように、傾斜した側面４，５を形成する。基板３の好ましい素材は、例えば、炭素鋼、ステンレス鋼、アルミ合金、ジルコニウムやアルミナのようなファインセラミックス、及びタングステンカーバイド（ＷＣ）のような超硬合金である。

第二工程では、図１（ｂ）に示すように、両表面４，５を仕上げるための研磨加工が行われる。なお、研磨加工は省略してもよい。

第三工程では、以下のように仕上げ刃付け加工が行なわれる。

図１（ｃ）に示すように、基板３の上端部分が削除（ボンバー処理）により仕上げられる。言い換えると、基板３の上端に近い位置に第一表面４ａ，５ａが形成され、基板３の上端が鋭利化される。尚、第一表面４ａ，５ａにそれぞれ連続する第二表面４ｂ，５ｂは削除前の表面４，５の一部分である。第一表面４ａ，５ａ間の刃付け角αａは第二表面４ｂ，５ｂ間の刃付け角αｂよりも大きいことが好ましい。第一表面４ａ，５ａと両第二表面４ｂ，５ｂとを面一に形成してもよい。この場合、２つの角αａ、αｂは等しくなる。また、両第一表面４ａ，５ａの刃付け角αａを両第二表面４ｂ，５ｂの刃付け角αｂよりも小さくしてもよい。第三工程は、スパッタエッチング法などのドライエッチング法により行うことが好ましい。基板３の上端部分の削除寸法Ｌ１は１０～２００ｎｍであることが好ましい。刃付け角αｂは１７～２５度であることが好ましく、刃付け角αａは１７～３０度であることが好ましい。

第四工程では、図１（ｄ）に示すように、基板３が被覆層６により覆われる。被覆層６は基板３の表面４，５にほぼ沿うように形成された左側面７と右側面８

とを有する。

第五工程では、図１（ｅ）に示すように、基板３の上端近傍の被覆層６が削除により仕上げられる。言い換えると、被覆層６の上端に近い位置に第一表面７ａ，８ａが形成され、被覆層６の上端が鋭利化される。尚、第一表面７ａ，８ａにそれぞれ連続する第二表面７ｂ，８ｂは削除前の被覆層６の表面７，８の一部分である。第一表面７ａ，８ａ間の刃付け角βａは第二表面７ｂ，８ｂ間の刃付け角βｂよりも大きいことが好ましい。第一表面７ａ，８ａが両第二表面７ｂ，８ｂと面一になるように形成してもよい。この場合、２つの角βａ、βｂは等しくなる。また、両第一表面７ａ，８ａの刃付け角βａを両第二表面７ｂ，８ｂの刃付け角βｂよりも小さくしてもよい。第五工程は、スパッタエッチング法などのドライエッチング法により行うことが好ましい。被覆層６の上端部分の削除寸法Ｌ２は５～１５０ｎｍであることが好ましい。刃付け角βｂは１７～３０度であることが好ましく、刃付け角βａは１７～４５度であることが好ましい。

第六工程では、図１（ｆ）に示すように、被覆層６上にフッ素樹脂層９が形成される。フッ素樹脂層９により使用時における刃１の滑りが向上される。フッ素樹脂層９の素材は、例えば、ポリテトラフルオロエチレン（ＰＴＦＥ）である。

図２（a）、２（b）、３、４（a）、４（b）、５（a）、５（b）、５（c）、５（d）の各々は、好ましい被覆層６の拡大断面図である。以下、各図の被覆層６について説明する。

図２（a）、２（b）の被覆層６の素材は、プラチナ（Ｐｔ）、ジルコニウム（Ｚｒ）、タングステン（W）とチタン（Ｔｉ）、銀（Ａｇ）、銅（Ｃｕ）、コバルト（Ｃｏ）、鉄（Ｆｅ）、ゲルマニウム（Ｇｅ）、アルミニウム（Ａｌ）、マグネシウム（Ｍｇ）、亜鉛（Ｚｎ）、及びクロム（Ｃｒ）からなる群から選択される少なくとも一つの金属と、ダイヤモンドライクカーボン（ＤＬＣ）のような硬質カーボン材料とを含む。

図２（ａ）に示す被覆層６は、上記の選択された金属が、ＤＬＣ中にほぼ均一に混合された混合層１０ａである。他方、図２（ｂ）に示す被覆層６は、上記の

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選択された金属の比率（濃度）が基板３の表面４，５に向かって変化している混合層１０ｂである。言い換えると、混合層１０ｂ中において、選択された金属の濃度は、基板３に近づくほど高くあるいは低くなっている。例えば、選択された金属の濃度が基板３に近づくほど高い場合、混合層１０ｂ（被覆層６）と基板３との密着が向上され、混合層１０ｂ（被覆層６）が基板３から剥がれるのが防止されるので好ましい。

図３に示す被覆層６は、基板３の表面４，５を被覆する中間層１１と、基板３の表面４，５に被覆した中間層１１と、中間層１１の表面１１ａを被覆する硬質カーボン層（ＤＬＣ層）１２とを含む。中間層１１の主成分はＰｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属である。

図４（ａ）、４（ｂ）に示す被覆層６は、基板３の表面４，５を被覆する中間層１１と、中間層１１の表面１１ａを覆う混合層１０ａ、１０ｂとからなる。中間層１１の主成分はＰｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属である。混合層１０ａ、１０ｂの各々は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と、硬質カーボン材料例えばＤＬＣとの混合物である。図４（ａ）の混合層１０ａでは、上記の選択された金属が、ＤＬＣ中にほぼ均一に混合されている。他方、図４（ｂ）に示す混合層１０ｂは、上記の選択された金属の比率（濃度）が、中間層１１の表面１１ａ（基板３の表面４，５）に向かって傾斜している。言い換えると、混合層１０ｂ中において、選択された金属の濃度は、中間層１１に近づくほど高くあるいは低くなっている。選択された金属の濃度は中間層１１に近づくほど高いことが好ましい。この場合、混合層１０ｂと中間層１１との密着が向上し、混合層１０ｂが中間層１１から剥がれるのが防止される。

図５（ａ）に示す被覆層６は、図４（ａ）の混合層１０ａを被覆するＤＬＣ層１２を含む。

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図５（ｂ）に示す被覆層６は、図４（ｂ）の混合層１０ｂを被覆するＤＬＣ層１２を含む。図５（ｂ）の混合層１０ｂ中の選択された金属の濃度は中間層１１に近づくほど高いことが好ましい。この場合、混合層１０ｂと中間層１１との密着が向上し、混合層１０ｂが中間層１１から剥がれるのが防止される。また、そのような混合層１０ｂでは、ＤＬＣ層１２に近づくほど炭素の濃度が高いので、ＤＬＣ層１２と混合層１０ｂとの密着が向上し、ＤＬＣ層１２が混合層１０ｂから剥がれるのが防止される。その結果、刃１の歯切れ味及び耐久性はさらに向上する。

図５（ｃ）に示す被覆層６は、図５（ａ）の単独の混合層１０ａの代わりに、複数（例えば３つ）の混合層１３ａ，１３ｂ，１３ｃを含む。混合層１３ａ，１３ｂ，１３ｃの各々は均一な金属組成を有する。図５(ｃ)の混合層１３ａ，１３ｂ，１３ｃの組成は互いに異なる。

図５（ｄ）に示す被覆層６は、図５（ｂ）に示す単独の混合層１０ｂの代わりに、複数（例えば３つ）の混合層１３ａ，１３ｂ，１３ｃを含む。図５（ｄ）の混合層１３ａ，１３ｂ，１３ｃの各々は濃度傾斜を有する金属を含有する。

図５(ｃ)及び５（ｄ）の混合層１３ａ，１３ｂ，１３ｃの各々は、上記の金属群から任意に選択される金属又はその化合物を含む。好ましくは、その化合物は、例えば、＊Ｎ（窒化物）と＊ＣＮ（炭窒化物）と＊Ｃ（炭化物）とから任意に選択したものである。記号＊は上記の金属群中の少なくとも一つの金属を表す。

そのほか、図２（ａ）、２（ｂ）、４（ａ）、４（ｂ）、５（ａ）及び５（ｂ）の混合層１０ａ，１０ｂ、図５（ｃ）、５（ｄ）の混合層１３ａ，１３ｂ，１３ｃ、図3、図４（ａ）、４（ｂ）及び図５（ａ）～５（ｄ）の中間層１１は複数積層してもよい。なお、刃先２の全体又は刃先２の一部が被覆層６により被覆される。また、刃先２は複数種類の被覆層６により被覆されてもよい。

被覆層６の形成は、高周波スパッタ、高速低温スパッタ（マグネトロンスパッタ）、反応性スパッタ（リアクティブスパッタ）等のスパッタリング法、各種蒸着法、各種イオンプレーティング法、各種気相成長法（ＣＶＤ）のような方法に従

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って行われる。

硬質カーボンには例えばダイヤモンドも含まれる。

Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ及びＣｒは、単体、添加物を含む合金、それらの窒化物、酸化物、ほう化物及び炭化物を含む。混合層１０ａ，１０ｂ，１３ａ，１３ｂ，１３c、ＤＬＣ層１２として、$C_3N_4$を利用してもよい。$C_3N_4$は、結晶性のものを含み、ダイヤモンドに類似した機械的特性を示し、且つ、理論的にはダイヤモンドよりも硬い。$C_3N_4$の層は、イオン化マグネトロンスパッタリング、アークプラズマジェットＣＶＤ、パルスレーザー蒸着、又は反応性イオン化クラスタビーム法などにより形成される。

＜実施例＞

以下、図１（ｆ）の刃先２を有する剃刀刃１の性質及び性能を説明する。

まず、剃刀刃１の製造工程をより詳細に説明する。

図１（ａ）に示す第一工程では、ステンレス鋼製の基板３に、荒砥石を用いた研削により刃付け工程が行われる。表面４，５間の刃付け角αｂは１７～２５度に設定される。図１（ｂ）に示す第二工程では、両表面４，５が皮砥研磨により仕上げられる。図１（ｃ）に示す第三工程では、第一表面４ａ，５ａ間の刃付け角αａが第二表面４ｂ，５ｂ間の刃付け角αｂよりも大きくなるように、スパッタエッチング法により基板３の上端近傍が削除される。

本実施例では、図１（ｄ）、１（ｅ）の工程の代わりに、図６（ａ）～６（ｃ）の工程が行われる。図６（ａ）では、基板３を覆う中間層１１がスパッタリングにより形成される。中間層１１の膜厚は５～１００ｎｍであり、かつ、最終的な被覆層６の膜厚の５～５０％であることが好ましい。本実施例では、中間層１１の膜厚は約２５ｎｍであり、最終的な被覆層６の膜厚の約２５％であった。

図６（ｂ）では、中間層１１の表面１１ａを覆うＤＬＣ層１２がスパッタリングにより形成される。ＤＬＣ層１２の膜厚は、１０～２００ｎｍであることが好ましく、本実施例では約７５ｎｍであった。

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図６（ｃ）では、ＤＬＣ層１２に鋭利な上端部分を形成するように、ＤＬＣ層１２の上端がスパッタエッチング法により削除される。削除寸法Ｌ２は好ましくは５～１５０ｎｍであり、さらに好ましくは５０～１００ｎｍである。削除後の第一表面７ａ，８ａ間の刃先角βａは１７～４５度であり、削除前の刃先角βｂは１７～３０度であった。

＜実施例１、２＞

剃刀刃１の諸性質

基板３をＣｒ１００％の被覆層で覆った刃先（図示せず）を有する比較例１の刃と、図６（ｂ）の処理後の刃先（ＤＬＣ通常成膜）を有する実施例１の刃と、図６（ｃ）の処理後の刃先（ＤＬＣ鋭利化成膜）を有する実施例２の刃とを用意し、各刃の形状、性質、性能等を調べた。

実施例１、２及び比較例１の刃をＳＥＭ（走査型電子顕微鏡）により観察し、尖端の曲率半径を測定した。その結果を表１に示す。

表１

| | 半径(nm) |
|---|---|
| 比較例1 | 28 |
| 実施例1 | 32 |
| 実施例2 | 6 |

表１から、実施例２の刃先２の曲率半径は比較例１及び実施例１の曲率半径よりも顕著に小さいことが分かった。すなわち、第五工程の鋭利化により、刃先２の鈍化が解消され、かつ、鋭利な刃先２を有する刃１が得られた。

実施例１、２及び比較例１の刃を用いて、均一なウールフェルト製の帯を一定回数連続切断した。各刃毎の切れ味を、初回切断時の抵抗値ａと最終切断時の抵抗値ｂの測定により調べた。また、刃の耐久性を式｛(ｂ－ａ）／ａ｝×１００で表される切断抵抗の増加率に従って調べた。その結果を表２に示す。

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表２

| | 初期値ａ(mN) | 最終値ｂ(mN) | 増加率(%) |
|---|---|---|---|
| 比較例１ | 365×9.8 | 700×9.8 | 91.8 |
| 実施例１ | 359×9.8 | 689×9.8 | 90.4 |
| 実施例２ | 320×9.8 | 649×9.8 | 90.1 |

表２から、実施例１及び２の刃のａ値、ｂ値及び増加率は、比較例１の刃のものよりも小さかった。これは、低摩擦係数のＤＬＣによる効果と考えられる。また、実施例２の刃のａ値、ｂ値及び増加率は、実施例１の刃のものよりも小さかった。従って、実施例２の刃は向上された切れ味を有し、その切れ味が維持されることが分かった。これは、鋭利化による効果と考えられる。

切れ味試験後に、実施例１、２及び比較例１の刃の刃先の変形をＳＥＭを用いて観察した。観察領域は刃先の長手方向における１ｍｍの範囲に限定し、長手方向に１μｍ以上にわたって変形した箇所を数えた。その結果を表３に示す。

表３

| | 変形箇所数 |
|---|---|
| 比較例１ | 12 |
| 実施例１ | 9 |
| 実施例２ | 8 |

表３から実施例１及び２の変形箇所数は、比較例１のものよりも少なかった。また、実施例２の変形箇所数は、実施例１のものと同程度であり、鋭利化したにもかかわらず、増加しなかった。

実施例１、２及び比較例１の刃を装着したＴ型剃刀を用意し、各刃についての切れ味を無作為に選ばれた１０名の被験者Ａ～Ｊの官能試験により評価した。切れ味の評価は１０点満点で数値化された。得点が高いほど高い切れ味であることを表す。結果を表４にまとめた。

表４

| 被験者 | 得点 | | |
|---|---|---|---|
| | 比較例１ | 実施例１ | 実施例２ |
| A | 7 | 8 | 9 |
| B | 8 | 8 | 8 |
| C | 7 | 8 | 10 |
| D | 9 | 9 | 9 |
| E | 7 | 8 | 8 |
| F | 5 | 6 | 6 |
| G | 6 | 7 | 7 |
| H | 8 | 8 | 10 |
| I | 5 | 6 | 8 |
| J | 5 | 5 | 5 |
| 平均 | 6.7 | 7.3 | 8.0 |

実施例２の平均得点が最も高かった。また、実施例１の平均得点は比較例１のものよりも高かった。

以上の比較結果から、被覆膜６の鋭利化により、切れ味の向上された刃１が得られることが分かった。また、刃１の切れ味の耐久性が向上されることが分かった。特に、刃先２の尖端の曲率半径が２５ｎｍ以下であるときに、より高い効果が得られる。鋭利化された被覆による効果は図２（ａ）～図５（ｄ）の被覆層６、及び積層された被覆層６でも得られる。

＜実施例３，４＞

実施例３，４では、顕微鏡試料作成用のミクロトームについて説明する。

基板３をＣｒ１００％の被覆層で覆った刃先（図示せず）を有する比較例２の刃と、図６（ｂ）の処理後の刃先（ＤＬＣ通常成膜）を有する実施例３の刃と、図６（ｃ）の処理後の刃先（ＤＬＣ鋭利化成膜）を有する実施例４の刃とを用意した。

以下のようにして、ミクロトーム刃の切断限度回数を調べた。まず、豚の肝臓を埋設した所定長さのパラフィンブロックを準備した。ミクロトーム機に実施例３，４、比較例２の各刃を装着して、そのパラフィンブロックを薄切りした。得られた薄片を採取し、各採取薄片についての縮み度合を調べた。ちなみに、縮み

度合が小さいほど、小さい抵抗で切断されたことを示し、刃の切れ味が良いことを意味する。通常、薄切りをくり返すことにより、刃の切れ味が低下し、縮み度合は徐々に大きくなる。実施例４の縮み度合が最も小さく、次に実施例３であり、比較例２の縮み度合いが最も高かった。この傾向は、繰り返し切断後も同じであった。切断限度と思われる縮み度合になるまでの使用限度回数を表５に示す。

表５

| | 使用限度回数 |
|---|---|
| 比較例２ | 130 |
| 実施例３ | 175 |
| 実施例４ | 185 |

表５から、使用限度回数は、実施例４が最も多く、次に実施例３であり、比較例２が最も少ないことが分かった。これは、鋭利化された被覆層６による効果と考えられる。なお、ミクロトーム刃の場合、臓器の硬度に応じた切れ味や耐久性になるように、刃先角度$\beta a$は１５～４５度の範囲に設定されることが好ましい。

＜実施例５＞

次に、図２（ａ）に示すＤＬＣ－Ｐｔ混合層１０ａで被覆された刃先を有する実施例５の刃を用意した。比較のために、Ｃｒ１００％の被覆層で被覆された刃先を有する比較例１の刃と、Ｐｔ１００％の被覆層で被覆された刃先を有する比較例３の刃と、ＤＬＣ１００％の被覆層で被覆された刃先を有する比較例４の刃を用意した。実施例５，比較例１，３，４の刃について、形状、性質、性能等を調べた。

まず、実施例５及び比較例１，３，４の刃を用いて、均一なウールフェルト製の帯を一定回数連続切断した。各刃毎の切れ味を、初回切断時の抵抗値ａと最終切断時の抵抗値ｂの測定により調べた。また、刃の耐久性を式｛（ｂ－ａ）／ａ｝×１００で表される切断抵抗の増加率に従って調べた。また、ＳＥＭにより膜剥離の有無を観察した。

表6

| | 初期値a(mN) | 最終値b(mN) | 増加率(%) | 剥離 |
|---|---|---|---|---|
| 比較例1 | 365×9.8 | 700×9.8 | 91.8 | なし |
| 比較例3 | 363×9.8 | 720×9.8 | 97.8 | なし |
| 比較例4 | 357×9.8 | 690×9.8 | 91.2 | 一部 |
| 実施例5 | 359×9.8 | 680×9.8 | 87.9 | なし |

実施例５及び比較例４の刃のａ値、ｂ値及び増加率は、比較例１、３の刃のものよりも小さかった。これは、低摩擦係数のＤＬＣによる効果と考えられる。また、実施例５の刃のａ値、ｂ値及び増加率は、比較例４の刃のものよりも小さく、また、ＤＬＣ－Ｐｔ膜はＤＬＣ膜よりも剥離しにくいことが分かった。従って、実施例５の刃は向上された切れ味を有し、その切れ味が維持されることが分かった。

切れ味試験後に、実施例５及び比較例１，３，４の刃の刃先の変形をＳＥＭを用いて観察した。観察領域は刃先の長手方向における１ｍｍの範囲に限定し、長手方向に１μｍ以上にわたって変形した箇所を数えた。その結果を表７に示す。

表7

| | 変形箇所数 |
|---|---|
| 比較例1 | 12 |
| 比較例3 | 13 |
| 比較例4 | 9 |
| 実施例5 | 7 |

表７から実施例５の変形箇所数は、比較例１、３、４のものよりも少なかった。従って、ＤＬＣとＰｔとを含む被覆層６により、変形しにくい刃が得られることが分かる。

表８

| 被験者 | 使用限度回数 | |
|---|---|---|
| | 比較例３ | 実施例５ |
| A | 6 | 6 |
| B | 8 | 12 |
| C | 7 | 9 |
| D | 5 | 5 |
| E | 12 | 15 |
| F | 8 | 9 |
| G | 5 | 6 |
| H | 8 | 10 |
| I | 11 | 13 |
| J | 8 | 8 |

実施例５及び比較例３の刃を装着したＴ型剃刀を用意し、各刃についての使用限度数を比較した。表８に被験者Ａ～Ｊが申告した使用限界数をまとめた。その結果、１０人中７人の被験者は、実施例５の刃を有する剃刀の使用限度数が比較例３の刃を有する剃刀よりも多いと回答し、残りの３人の被験者は実施例５と比較例３の使用限度数は同じと回答した。従って、ＤＬＣ－Ｐｔ膜により、刃１の耐久性が実質的に向上されたことが分かった。

以上の比較から、ＤＬＣとＰｔとの混合により、ＤＬＣと基材３との密着性が向上し、被覆層の剥離が防止された。また、切れ味及び耐久性の向上された剃刀刃１が得られた。Ｐｔのような補助材としては、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ及びＣｒが好適に使用される。尚、Ｔｉ、Ａｇ、Ｃｕ及びＡｌは抗菌性を有するので、そのような補助材を含む被覆層を有する刃１は衛生的である。

＜実施例６，７＞

次に、図２（ａ）に示すＤＬＣ－Ｗ混合均一層１０ａで被覆された刃先を有する実施例６の刃と、図２（ｂ）に示すＤＬＣ－Ｗ混合傾斜層１０ｂで被覆された刃先を有する実施例７の刃とを用意した。比較のために、Ｗ１００％の被覆層で被覆された刃先を有する比較例５の刃を用意した。実施例６，７及び比較例５の

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刃について、形状、性質、性能等を調べた。

表9

| | 初期値a(mN) | 最終値b(mN) | 増加率(%) | 剥離 |
|---|---|---|---|---|
| 比較例5 | 380×9.8 | 725×9.8 | 94.5 | なし |
| 実施例6 | 358×9.8 | 695×9.8 | 92.3 | なし |
| 実施例7 | 355×9.8 | 675×9.8 | 87.7 | なし |

実施例6，７の刃のａ値、ｂ値及び増加率は、比較例５の刃のものよりも小さかった。これは、低摩擦係数のＤＬＣによる効果と考えられる。また、実施例７の刃のａ値、ｂ値及び増加率は、実施例６の刃のものよりも小さいことが分かった。これは、補助材Ｗの濃度傾斜の効果と考えられる。

切れ味試験後に、実施例６，７及び比較例５の刃の刃先の変形をＳＥＭを用いて観察した。観察領域は刃先の長手方向における１ｍｍの範囲に限定し、長手方向に１μｍ以上にわたって変形した箇所を数えた。その結果を表１０に示す。

表１０

| | 変形箇所数 |
|---|---|
| 比較例5 | 13 |
| 実施例6 | 8 |
| 実施例7 | 7 |

実施例6，７の変形箇所数は、比較例５のものよりも少なかった。従って、ＤＬＣとＷとを含む被覆層６により、変形しにくい刃が得られることが分かる。また、実施例７の変形箇所数は実施例６の変形箇所数よりも少なかった。これは、補助材Ｗの濃度傾斜の効果と考えられる。

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表１１

| 被験者 | 使用限度回数 | |
|---|---|---|
| | 実施例６ | 実施例７ |
| A | 12 | 13 |
| B | 9 | 11 |
| C | 5 | 10 |
| D | 9 | 12 |
| E | 8 | 9 |
| F | 6 | 7 |
| G | 13 | 15 |
| H | 10 | 10 |
| I | 8 | 9 |
| J | 8 | 8 |

実施例６，７の刃を装着したＴ型剃刀を用意し、各刃についての使用限度数を比較した。表１１に被験者Ａ～Ｊが申告した使用限界数をまとめた。その結果、１０人中８人の被験者は、実施例７の刃を有する剃刀の使用限度数が実施例６の刃を有する剃刀よりも多いと回答し、残りの２人の被験者は実施例６と７の使用限度数は同じと回答した。従って、ＤＬＣ−Ｗ濃度傾斜膜が刃１の耐久性を実質的に向上させることが分かった。

以上の比較から、ＤＬＣとＷとの混合により、ＤＬＣと基材３との密着性が向上し、被覆層の剥離が防止された。また、切れ味及び耐久性の向上された剃刀刃１が得られた。Ｗのような補助材としては、Ｐｔ、Ｚｒ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ及びＣｒが好適に使用される。

図８（ａ）～（ｃ）は第２実施形態の刃の製造工程を示す。図８（ａ）～（ｃ）において、被覆層６は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分としている。

図９は第３実施形態の刃１の断面図である。刃１は２つの被覆層６，６ａを有する。詳しくは、刃１は、図１（ｆ）のフッ素樹脂層９と被覆層６との間に形成された薄い被覆層６ａを有する。薄い被覆層６ａとして、前述した各種被覆層６と同一のものが使用される。

第１から第３実施形態によれば、向上された切れ味及び耐久性を有する刃１が得られる。また、抗菌効果のある補助材を含む被覆層６を形成することにより、衛生的な刃１が得られる。

鋭利化された被覆層６上に形成された被覆層６ａの表面の粗さを調製することにより、フッ素樹脂層９の密着性が向上される。

最外層に形成されたフッ素樹脂層９により、刃１の使用時の滑りが向上する。

第１から第３実施形態は、以下のように変更してもよい。

図１（ｃ）に示す基板３の両表面４，５上にフッ素樹脂層９を直接形成してもよい。

剃刀やミクロトーム以外に、例えば医療用メス、鋏、包丁、爪切り、工業用特殊刃に、本発明の刃１及びその製造方法を具体化してもよい。

## 請求の範囲

1．刃先を有する基板と、

前記基板の少なくとも刃先を覆う被覆層とから形成されており、前記被覆層が、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ及びＣｒからなる群から選択された少なくとも一つの金属と炭素材料とを含有する混合層を含むことを特徴とする刃。

2．刃先を有する基板と、少なくとも前記刃先を覆う被覆層とを備える刃において、前記被覆層が

Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、

前記中間層上に形成された炭素層とから形成されていることを特徴とする刃。

3．刃先を有する基板と、少なくとも前記刃先を覆う被覆層とを備える刃において、前記被覆層が、

Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、

前記中間層上に形成された混合層であって、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する前記混合層とから形成されていることを特徴とする刃。

4．前記混合層中の前記金属の濃度はほぼ均一であることを特徴とする請求項１または請求項３に記載の刃。

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５．前記混合層中の前記金属の濃度は当該混合層の表面に向かって変化していることを特徴とする請求項１または請求項３に記載の刃。

６．刃において、

尖端に向かって小さくなるように形成された刃先を有する基板と、

少なくとも前記刃先を覆う被覆層とを備え、前記被覆層は、前記刃先の尖端側において、当該被覆層を部分的に削除することにより形成され、かつ、当該尖端に向かって傾斜する少なくとも一つの傾斜面を有することを特徴とする刃。

７．前記少なくとも一つの傾斜面は、前記刃先の尖端において互いに接続される２つの第１傾斜面の一つであり、前記被覆層はさらに、前記刃先の尖端から離間した位置において、前記２つの第１傾斜面にそれぞれ連続して延びるように形成された２つの第２傾斜面を有することと、前記２つの第１傾斜面間の角度は、前記２つの第２傾斜面間の角度よりも大きいことを特徴とする請求項６に記載の刃。

８．前記被覆層上に形成された第２の被覆層をさらに有することを特徴とする請求項６または請求項７に記載の刃。

９．２つの表面により形成される刃先を有する基板を備える刃であって、前記刃先は、前記２つの表面の少なくとも一方を部分的に削除することにより形成された傾斜面を有することを特徴とする刃。

１０．前記傾斜面は、前記基板の２つの表面の各々に形成され、かつ、前記刃先の尖端において互いに接続される２つの第１傾斜面の一つであり、前記基板はさらに、前記刃先の尖端から離間した位置において、前記２つの第１傾斜面にそれぞれ連続して延びる２つの第２傾斜面を有することと、前記２つの第１傾斜面間の角度は、前記２つの第２傾斜面間の角度よりも大きいことを特徴とする請求項

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９に記載の刃。

１１．前記基板を覆う被覆層をさらに備える請求項９または１０に記載の刃。

１２．刃において、

２つの表面により形成される刃先を有する基板であって、前記基板の縁から前記２つの表面に沿ってそれぞれ延びる２つの第１内側傾斜面と、前記２つの第１内側傾斜面にそれぞれ連続して延びる２つの第２内側傾斜面とを有し、前記２つの第１内側傾斜面間の角度は、前記２つの第２内側傾斜面間の角度よりも大きい前記基板と、

前記基板を覆う被覆層であって、前記刃先の尖端において互いが接続される２つの第１外側傾斜面と、前記２つの第１外側傾斜面にそれぞれ連続して延びる２つの第２外側傾斜面とを有し、前記２つの第１外側傾斜面間の角度は、前記２つの第２外側傾斜面間の角度よりも大きい前記被覆層とを備えることを特徴とする刃。

１３．前記被覆層上に形成された第２の被覆層をさらに有することを特徴とする請求項１２に記載の刃。

１４．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する混合層を含むことを特徴とする請求項６、７、８または１１に記載の刃。

１５．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された炭素層とから形成されている

ことを特徴とする請求項６、７、８または１１に記載の刃。

１６．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された混合層であって、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する前記混合層とから形成されていることを特徴とする請求項６、７、８または１１に記載の刃。

１７．前記混合層中の前記金属の濃度はほぼ均一であることを特徴とする請求項１４または請求項１６に記載の刃。

１８．前記混合層中の前記金属の濃度は当該混合層の表面に向かって変化していることを特徴とする請求項１４または請求項１６に記載の刃。

１９．最外層がフッ素樹脂層で被覆されていることを特徴とする請求項１から請求項８、１１～１８のいずれか一項に記載の刃。

２０．前記基板は、剃刀刃あるいはミクロトーム刃用の基板であることを特徴とする請求項１から請求項１９のいずれか一項に記載の刃。

２１．刃の製造方法において、

２つの面を有する基板を用意し、

前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成し、

前記基板の少なくとも前記縁を覆う被覆層を形成し、

前記被覆層を部分的に削除することにより、前記被覆層の前記縁に対応する位

置から傾斜する、少なくとも一つの傾斜面を形成することを特徴とする方法。

２２．刃の製造方法において、

２つの面と、前記２つの面により区画される縁とを有する基板を用意し、

前記基板の少なくとも前記縁を覆う被覆層を形成し、

前記基板の２つの面に対応する前記被覆層の２つの表面のうち少なくとも一つを削除して傾斜面を形成し、

前記被覆層上に第２の被覆層を形成することを特徴とする方法。

２３．刃の製造方法において、

２つの面を有する基板を用意し、

前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成し、

前記基板の２つの面のうち少なくとも一つを削除して傾斜面を形成することを特徴とする方法。

２４．刃の製造方法において、

２つの面を有する基板を用意し、

前記２つの面の間隔が前記基板の縁に向かって小さくなるように前記基板の２つの面を形成し、

前記基板の２つの面のうち少なくとも一つを削除して傾斜面を形成し、

前記傾斜面を被覆する被覆層を形成することを特徴とする刃の製造方法。

２５．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する混合層を含むことを特徴とする請求項２１，２２，２４のいずれか一項に記載の刃の製造方法。

２６．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された炭素層とから形成されていることを特徴とする請求項２１，２２，２４のいずれか一項に記載の刃の製造方法。

２７．前記被覆層は、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属を主成分とする中間層と、前記中間層上に形成された混合層であって、Ｐｔ、Ｚｒ、Ｗ、Ｔｉ、Ａｇ、Ｃｕ、Ｃｏ、Ｆｅ、Ｇｅ、Ａｌ、Ｍｇ、Ｚｎ、及びＣｒからなる群から選択される少なくとも一つの金属と炭素材料とを含有する前記混合層とから形成されていることを特徴とする請求項２１，２２，２４のいずれか一項に記載の刃の製造方法。

２８．前記混合層中の前記金属の濃度はほぼ均一であることを特徴とする請求項２５または請求項２７に記載の刃の製造方法。

２９．前記混合層中の前記金属の濃度は当該混合層の表面に向かって変化していることを特徴とする請求項２５または２７に記載の刃の製造方法

３０．前記削除は、スパッタリング法、蒸着法、イオンプレーティング法及び気相成長法の少なくとも一つの方法で行なわれることを特徴とする請求項２１～２４のいずれか一項に記載の刃の製造方法。

３１．前記被覆層の形成は、スパッタリング法、蒸着法、イオンプレーティング法及び気相成長法の少なくとも一つの方法で行なわれることを特徴とする請求項２１，２２及び２４のいずれか一項に記載の刃の製造方法。

Fig.1a

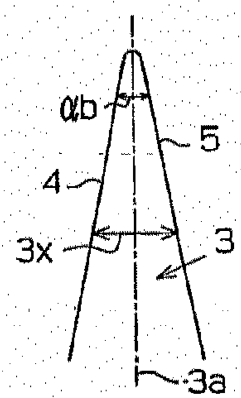



Fig.1b

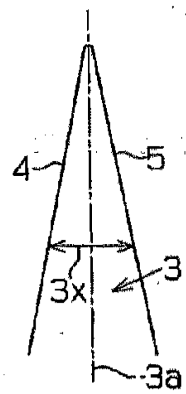



Fig.1c

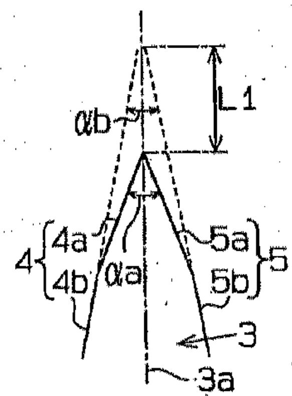



Fig.1d

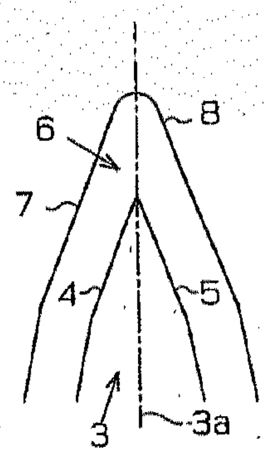



Fig.1e

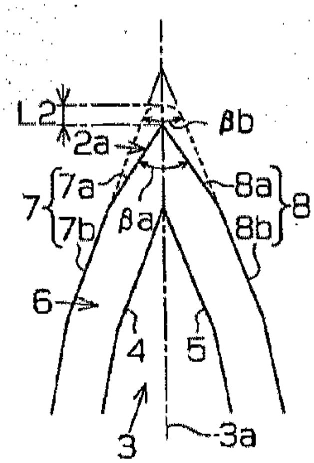



Fig.1f

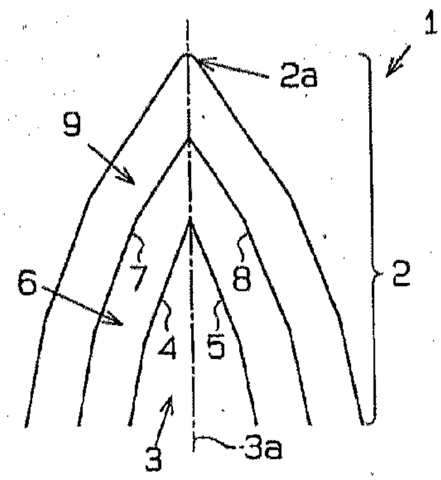


Fig.2a

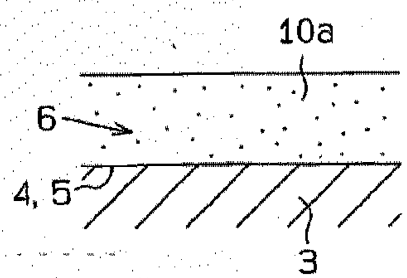



Fig.2b

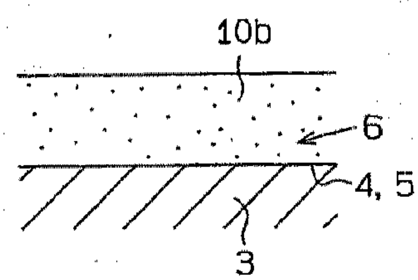



Fig.3

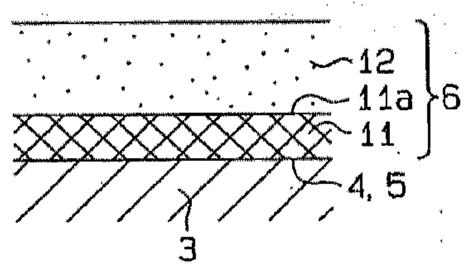



Fig.4a

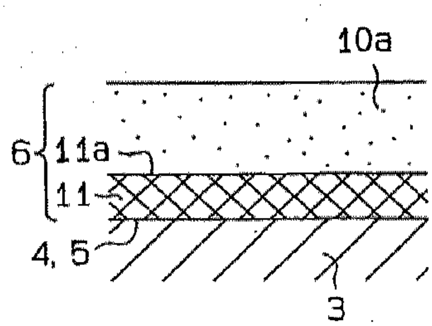



Fig.4b

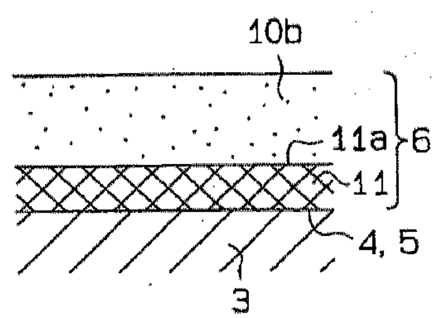


Fig.5a

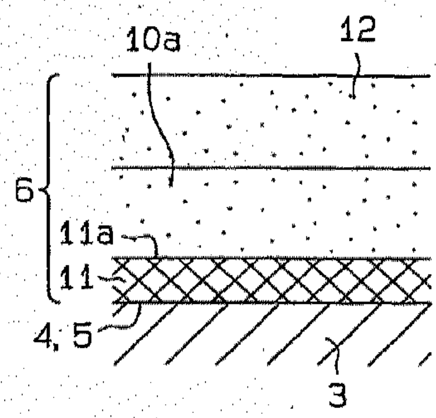



Fig.5b

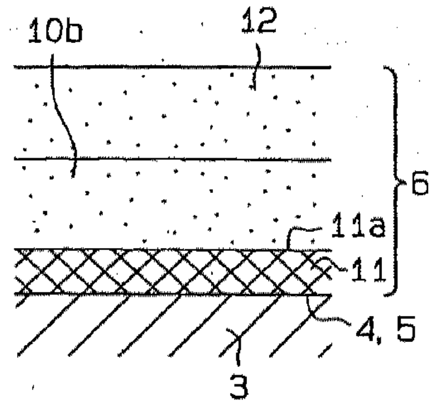



Fig.5c

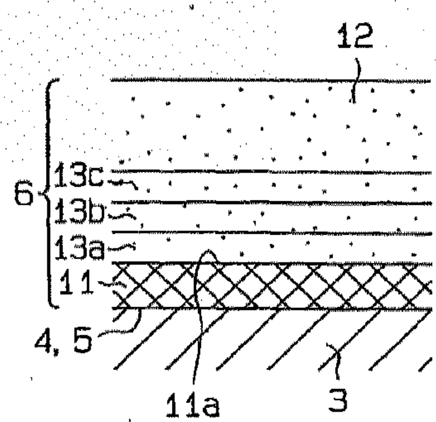
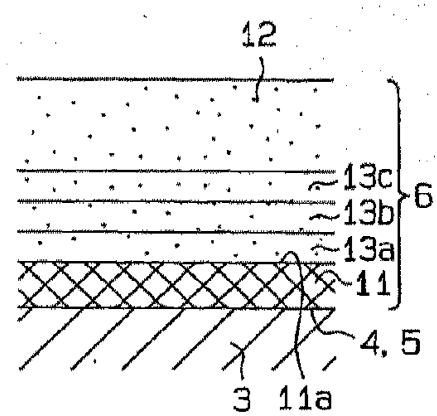



Fig.5d

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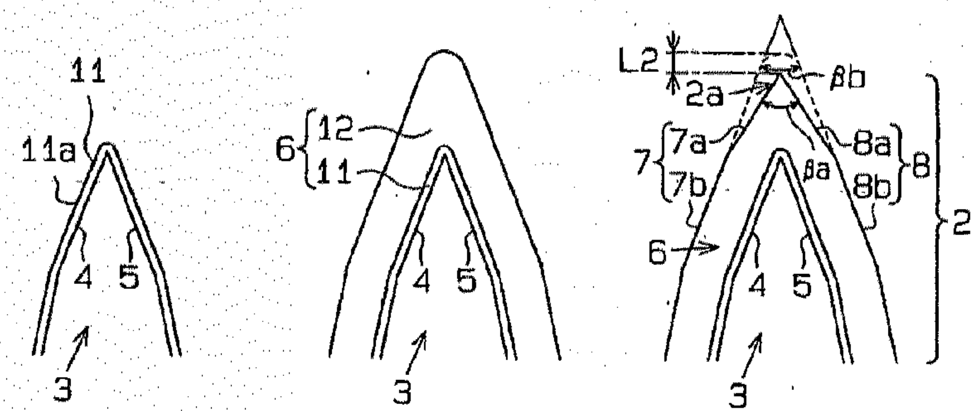



Fig.6a Fig.6b Fig.6c

Fig.7

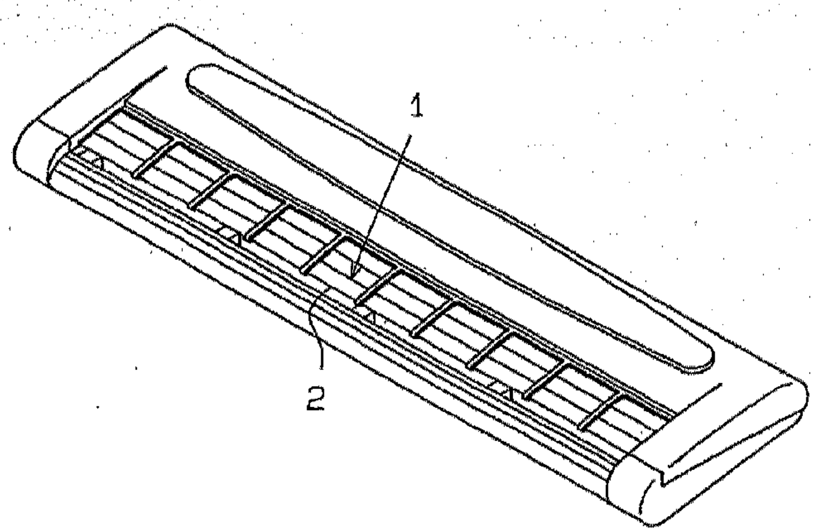


Fig.8a Fig.8b Fig.8c

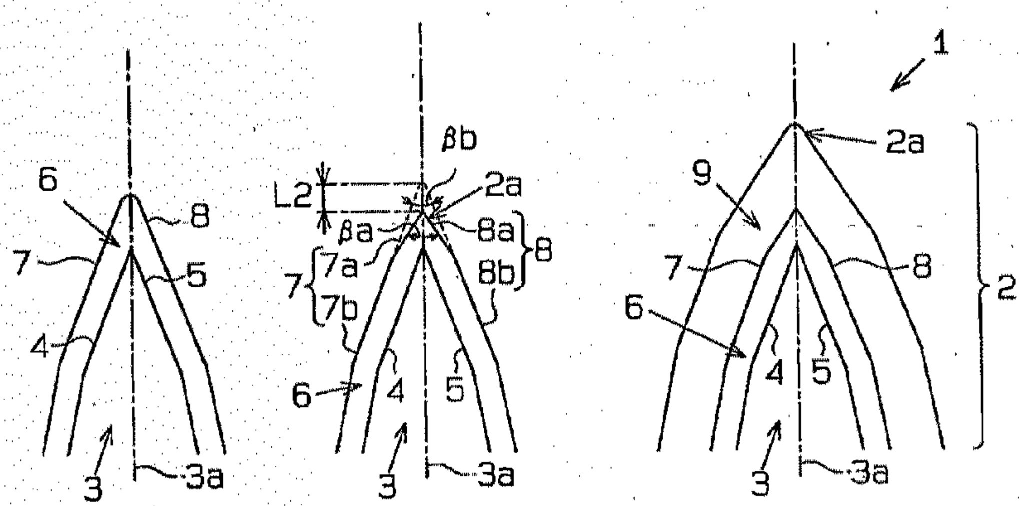
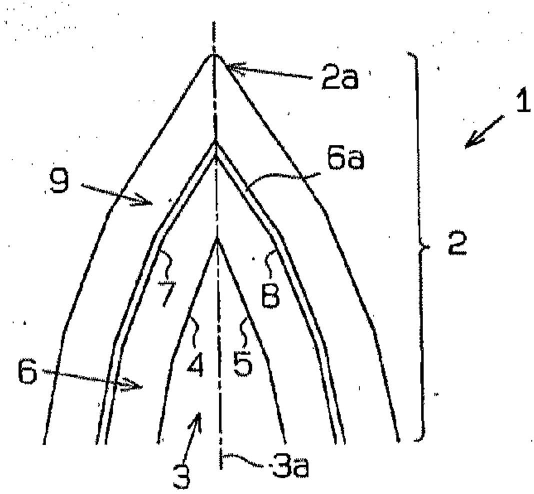



Fig.9



## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/04696

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B26B21/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B26B21/60

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

| | | | |
|---|---|---|---|
| Jitsuyo Shinan Koho | 1920-2001 | Jitsuyo Shinan Toroku Koho | 1996-2001 |
| Kokai Jitsuyo Shinan Koho | 1971-2001 | Toroku Jitsuyo Shinan Koho | 1994-2001 |

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y | US 5795648 A (Advanced Refractory Technologies, Inc.), 18 August, 1998 (18.08.98), column 3, line 66 to column 6, line 31; Fig. 6<br>& JP 11-512634 A & AU 7371296 A<br>& EP 1007351 A & WO 97/12757 A1<br>& CA 2233671 A & CN 1202852 A | 1-5<br>6-31 |
| Y | US 5032243 A (The Gillette Company), 16 July, 1991 (16.07.91), column 5, lines 64 to 66; Fig. 4<br>& JP 3-501458 A & GB 8921944 A<br>& WO 90/03455 A1 & EP 363648 A1<br>& DE 68905286 T | 6-9,21-31 |
| Y | JP 58-206788 A (Fuezaa Anzen Kamisori K.K.), 02 December, 1983 (02.12.83), Full text; Fig. 2 (Family: none) | 7,8,10-20 |
| Y | JP 60-160951 A (Kyocera Corporation), 22 August, 1985 (22.08.85), page 2, upper left column, line 12 to upper right column, line 2; Fig. 1 (Family: none) | 30,31 |

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| | |
|---|---|
| Date of the actual completion of the international search<br>07 September, 2001 (07.09.01) | Date of mailing of the international search report<br>18 September, 2001 (18.09.01) |
| Name and mailing address of the ISA/<br>Japanese Patent Office | Authorized officer |
| Facsimile No. | Telephone No. |

# INTERNATIONAL SEARCH REPORT

| International application No. |
|---|
| PCT/JP01/04696 |

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5295305 A (The Gillette Company),<br>22 March, 1994 (22.03.94),<br>Full text; Fig. 3<br>& JP 6-507100 A & DE 69230822 D<br>& WO 92/19425 A2 & EP 582676 A | 1-31 |



PACE-037462

国際調査報告

国際出願番号　PCT／JP01／04696

A.　発明の属する分野の分類（国際特許分類（IPC））
Int. Cl⁷ B26B21／60

B.　調査を行った分野
調査を行った最小限資料（国際特許分類（IPC））
Int. Cl⁷ B26B21／60

最小限資料以外の資料で調査を行った分野に含まれるもの
日本国実用新案公報　　1920－2001年
日本国公開実用新案公報　1971－2001年
日本国実用新案登録公報　1996－2001年
日本国登録実用新案公報　1994－2001年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

C.　関連すると認められる文献

| 引用文献のカテゴリー＊ | 引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示 | 関連する請求の範囲の番号 |
|---|---|---|
| X<br>Y | US 5795648 A (Advanced Refractory Technologies,Inc.)，18．8月．1998（18．08．98），第3欄第66行－第6欄第31行，第6図，& JP 11－512634 A，& AU 7371296 A，& EP 1007351 A，& WO 97／12757 A1，& CA 2233671 A，& CN 1202852 A | 1-5<br>6-31 |
| Y | US 5032243 A (The Gillette Company)，16．7月．1991（16．07．91），第5欄第64行－第66行，第4図，& JP 3－501458 A，& GB 88219 | 6-9，21-31 |

☒ C欄の続きにも文献が列挙されている。　　☐ パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「T」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「X」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Y」特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリー文献

| | |
|---|---|
| 国際調査を完了した日　07．09．01 | 国際調査報告の発送日　18.09.01 |
| 国際調査機関の名称及びあて先<br>日本国特許庁（ISA／JP）<br>郵便番号100－8915<br>東京都千代田区霞が関三丁目4番3号 | 特許庁審査官（権限のある職員）　3C　9618<br>田村　耕作<br>電話番号　03－3581－1101　内線　3324 |

様式PCT／ISA／210（第2ページ）（1998年7月）

PACE-037463

| C（続き）． | 関連すると認められる文献 | |
| --- | --- | --- |
| 引用文献の<br>カテゴリー＊ | 引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示 | 関連する<br>請求の範囲の番号 |
| | 44 A，& WO 90／03455 A1，& EP 363648 A1，& DE 68905286 T | |
| Y | JP 58－206788 A（フェザー安全剃刀株式会社），2．12月．1983（02．12．83），全文，第2図（ファミリーなし） | 7，8，10－20 |
| Y | JP 60－160951 A（京セラ株式会社），22．8月．1985（22．08．85），第2頁左上欄第12行－右上欄第2行，第1図（ファミリーなし） | 30，31 |
| A | US 5295305 A（The Gillette Company），22．3月．1994（22．03．94），全文，第3図，& JP 6－507100 A，& DE 69230822 D，& WO 92／19425 A2，& EP 582676 A | 1－31 |



PACE-037464

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 12/16/2004

FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | |

DATE MAILED: 12/16/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

PACE-037465

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 10/379,264 | CLIPSTONE ET AL. |
| | Examiner | Art Unit |
| | Stephen Choi | 3724 |

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *16 September 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *2,4-6,9-11,13 and 22-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2,4-6,9-11,13,22-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *04 March 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *6/25,9/2,10/8*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Information Disclosure Statement*

1. Acknowledgment is made of applicant's submission of a preliminary amendment and an IDS on 23 June 2204. The preliminary amendment and the IDS were not entered timely by the Office for the examiner to consider at the time of the previous office action. The preliminary amendment incorporates the limitations of claim 3 to claim 2. Since claim 3 was rejected on the same ground as claim 2 in the previous office action, the same rejection applies to the claims in the preliminary amendment. Thus, claim 2 as amended by the preliminary amendment has been properly treated and fully considered on the merits. The IDS has been considered and an initialed copy of PTO-1449 is attached with this office action.

### *Claim Objections*

2. Claim 6 is objected to because of the following informalities: –is-- should be added after "material". Appropriate correction is required.

### *Claim Rejections - 35 USC § 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 2, 4-5, 11, 13, and 22-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goel et al. (US 5,795,648) in view of Wang (US 6,331,332).

Goel discloses the invention substantially as claimed except for a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorus diamond. Instead, Goel teaches use of a coating including DLN materials doped with chromium wherein the coating includes 0.1 to 10 atomic percent chromium. Wang teaches a coating of DLC doped with chromium to provide good adhesion. It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a coating of DLC doped with chromium as taught by Wang in lieu of DLN materials doped with chromium of Goel as an alternative coating to improve preservation of edges on a substrate with good adherence to the substrate. Regarding claims 4 and 22, see col. 5, lines 34-54 of Goel. Regarding claim 11, col. 3, lines 34-43 and col. 4, lines 14-16.

5. Claims 6, 9-10, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goel in view of Wang, as applied to claims 2 and 13 above, and further in view of Clipstone et al. (US 6,684,513).

The modified device of Goel discloses the invention substantially as claimed except for an overcoat layer comprising chromium. Clipstone discloses an overcoat layer comprising chromium. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the modified blade of Goel with the overcoat chromium layer as taught by Clipstone in order to provide improved adhesion of PTFE layer. Regarding claims 6 and 24, the modified device of Goel fails to disclose the carbon-containing material is amphorous diamond. However, Clipstone teaches amphorous diamond is one type of carbon containing materials used for hard coating. It

would have been obvious to one having ordinary skill in the art at the time the invention was made to select amphorous diamond as an alternative hard coating material on the modified device of Goel.

***Response to Arguments***

6. Applicant's arguments with respect to claims 2, 4-6, 9-11, 13, and 22-24 have been considered but are moot in view of the new ground(s) of rejection.

***Conclusion***

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen Choi whose telephone number is 571-272-4504. The examiner can normally be reached on Monday-Friday 9:00-3:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Allan Shoap can be reached on 571-272-4514. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

sc
10 December 2004

STEPHEN CHOI
PRIMARY EXAMINER

| Substitute Form PTO-1449 (Modified) | U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b)) | | Applicant Colin Clipstone et al. | |
| | | Filing Date March 4, 2003 | Group Art Unit 3724 |

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## U.S. Patent Documents

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| W | AA | US 2004/0099120 A1 | 05/27/04 | Yamada et al. | — | — | |
| | AB | | | | | | |
| | AC | | | | | | |
| | AD | | | | | | |
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## Foreign Patent Documents or Published Foreign Patent Applications

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| | AL | | | | | | | |
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## Other Documents (include Author, Title, Date, and Place of Publication)

| Examiner Initial | Desig. ID | Document |
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| | AQ | |
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| Examiner Signature | Date Considered |
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| Ali | 12/10/04 |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

**U.S. Patent Documents**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| h | AA | 6,110,532 | 08/29/00 | Causton et al. | — | — | |
| h | AB | 5,992,268 | 11/30/99 | Decker et al. | — | — | |
| | AC | | | | | | |
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**Foreign Patent Documents or Published Foreign Patent Applications**

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| h | AL | WO 01/64406 | 09/07/01 | PCT | — | — | | |
| h | AM | WO 87/04471 | 07/30/87 | PCT | — | — | | |
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| | AP | | | | | | | |

**Other Documents (include Author, Title, Date, and Place of Publication)**

| Examiner Initial | Desig. ID | Document |
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| | AQ | |
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| Examiner Signature | Date Considered |
|---|---|
| Ali | 12/10/04 |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Substitute Disclosure Form (PTO-1449)

OIPE JC19
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PATENT & TRADEMARK OFFICE



| Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office | Attorney's Docket No. 00216-607001 | Application No. 10/379,264 |
|---|---|---|
| **Information Disclosure Statement by Applicant** (Use several sheets if necessary) | Applicant Colin Clipstone et al. | |
| (37 CFR §1.98(b)) | Filing Date March 4, 2003 | Group Art Unit 3724 |

## U.S. Patent Documents

| Examiner Initial | Desig. ID | Document Number | Publication Date | Patentee | Class | Subclass | Filing Date If Appropriate |
|---|---|---|---|---|---|---|---|
| | AA | | | | | | |
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## Foreign Patent Documents or Published Foreign Patent Applications

| Examiner Initial | Desig. ID | Document Number | Publication Date | Country or Patent Office | Class | Subclass | Translation Yes | Translation No |
|---|---|---|---|---|---|---|---|---|
| h | AL | WO 01/94083 | 12/13/01 | PCT (English Abstract Only) | — | — | | X |
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## Other Documents (include Author, Title, Date, and Place of Publication)

| Examiner Initial | Desig. ID | Document |
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| | AQ | |
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| Examiner Signature | Date Considered |
|---|---|
| Ali | 12/10/04 |

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

## Index of Claims

| Application No. | Applicant(s) |
|---|---|
| 10/379,264 | CLIPSTONE ET AL. |
| **Examiner** | **Art Unit** |
| Stephen Choi | 3724 |

| √ | Rejected | — | (Through numeral) Cancelled | N | Non-Elected | A | Appeal |
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OIPE JC112 FEB 11 2005 PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 00216-607001 / Case 8104

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

**MAIL STOP AF**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT IN REPLY TO ACTION OF DECEMBER 16, 2004

Please amend the above-identified application as follows:

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

February 9, 2005
Date of Deposit

Sherry L Hunt
Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

PACE-037475

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Cancelled).

2. (Previously Presented) A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond, doped with chromium or an alloy of chromium, on the cutting edge, the coating including from 0.1 to 10 atomic percent chromium; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating consisting of the carbon-containing material and the cutting edge.

3. (Cancelled).

4. (Previously Presented) The razor blade of claim 2, wherein the coating consisting of the carbon-containing material includes from 1 to 5 atomic percent chromium.

5. (Previously Presented) The razor blade of claim 2, wherein the carbon-containing material is diamond-like carbon.

6. (Currently Amended) The razor blade of claim 2, wherein the carbon-containing material <u>is</u> amphorous diamond.

7.-8. (Cancelled).

9. (Previously Presented) The razor blade of claim 2, further comprising an overcoat layer between the coating consisting of the carbon-containing material and the coating of polytetrafluoroethylene.

10. (Original) The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. (Previously Presented) The razor blade of claim 2, wherein the coating consisting of the carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

12. (Cancelled).

13. (Previously Presented A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond doped with chromium or an alloy of chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

14.-21. (Cancelled).

22. (Previously Presented) The shaving razor of claim 13, wherein the coating consisting of a carbon-containing material includes from 1 to 5 atomic percent chromium.

23. (Previously Presented) The shaving razor of claim 13, wherein the carbon-containing material is diamond-like carbon.

24. (Previously Presented) The shaving razor of claim 13, wherein the carbon-containing material is amphorous diamond.

## REMARKS

The pending claims relate to a razor blade (and shaving razors including the blade) having a substrate with a cutting edge and a carbon coating consisting of diamond-like carbon ("DLC"), diamond, and/or amphorous diamond doped with chromium. Significantly, the blade does not include an interlayer between the carbon coating and the substrate. As applicants explained on page 5 of the application, "[i]t is believed that the presence of the chromium dopant aids in the adhesion between the hard carbon layer and the cutting edge."

Claims 2, 4, 5, 11, 13, 22, and 23 were rejected under 35 U.S.C. § 103(a) over Goel et al., U.S. Pat. 5,795,648 ("Goel") in view of Wang, U.S. Pat. 6,331,332 ("Wang"). Applicants respectfully request that the rejection be reconsidered and withdrawn for the following reasons.

Goel discloses a razor blade with a diamond-like nanocomposite ("DLN") coating. The DLN coating includes a carbon material and a glass-like silica network. Goel calls this a "two-component network". See, e.g., col. 4, lines 25-31 and 63-66. That network may further be doped with a dopant network to provide a three-component network. See col. 4, line 41 - col. 5, line 6. The glass-like silica network in a crucial part of the DLN coating. As Goel explains (col. 6, lines 6-16, emphasis added):

> As already mentioned, to improve adherence of coatings, DLC coatings often require an intermediate layer between the substrate and the DLC coating. Often, if the DLC coatings are too thick, delamination occurs. Surprisingly, with the DLN coatings of the present invention, adherence is so good that an interlayer is usually not required. As a result, the DLN coating may be applied directly to the substrate, and more thickly, without risking delamination from the substrate The ability to apply a thicker layer of DLN coating results from the low intrinsic stress due to the Si-O network, and is believed to contribute to the superior erosion resistance of the DLN-coated substrates.

Thus, Goel teaches that superior adherence, with resulting good erosion resistance, is achieved because the DLN coating includes the glass-like silica network.

Wang describes a method of depositing DLC coatings on substrates such as semi-conductors, optics, and wear-resistant mechanical components. See col. 4, lines 32-35. The DLC maybe doped, for example, with chromium. Wang explains that the DLC coating including chromium (col. 4, lines 4-8)

> possesses good adhesion to substrate and reduced residual stress especially with the aid of one or more interlayers of metal, metal nitride, or metal carbide formed on the substrate before the formation of DLC film

Thus, Wang teaches that an interlayer is important for achieving good adherence for the DLC coating doped with chromium.

A person of ordinary skill in the art looking to achieve good adherence of a DLC coating to a razor blade would not be motivated to use DLC doped with chromium directly (i.e., without an interlayer) on a blade based on Goel and Wang. Goel teaches that the glass-like silica network is crucial to providing good adherence of the DLN coating to a substrate in the absence of an interlayer. Obviously, a person of ordinary skill in the art, reading Goel, would not be motivated to remove the glass-like silica network. Wang does not relate to razor blades and a person of ordinary skill in the art would not look to Wang for guidance in designing razor blades. But even if someone designing a razor blade reviewed Wang, Wang teaches that the best adherence occurs when the substrate includes an interlayer between the DLC layer and the substrate.

If a person of ordinary skill in the art, designing a razor blade including a DLC layer, reviewed Goel and Wang, that person would be led to (1) include an interlayer between the DLC layer and the substrate in the absence of a glass-like carbon network in the DLC, or (2) include a glass-like silica network in the DLC to avoid using an interlayer. Thus, neither Goel or Wang, alone or in combination, suggests a razor blade including a carbon coating consisting of DLC doped with chromium but lacking an interlayer. As a result, the 35 U.S.C. § 103(a) rejection based on Goel and Wang should be withdrawn.

Clipstone et al., U.S. Pat. 6,684,513 ("Clipstone") was cited in combination with Goel and Wang in making a 35 U.S.C. § 103(a) rejection of some of the dependent claims (claims 6, 9, 10, and 24). Clipstone does not cure the deficiencies of Goel and Wang discussed above and this rejection should be withdrawn for at least the same reasons should be withdrawn as well.

Applicants submit that the claims are in condition for allowance and such action is requested.

Please apply any other charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: February 9, 2005

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

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10/379 264

# PATENT APPLICATION FEE DETERMINATION RECORD

Effective January 1, 2003

Application or Docket Number: 10,379264

## CLAIMS AS FILED - PART I

| | (Column 1) | (Column 2) | SMALL ENTITY TYPE ☐ RATE | FEE | OR | OTHER THAN SMALL ENTITY RATE | FEE |
|---|---|---|---|---|---|---|---|
| TOTAL CLAIMS | 21 | | BASIC FEE | $375 | OR | BASIC FEE | $750 |
| FOR | NUMBER FILED | NUMBER EXTRA | | | | | |
| TOTAL CHARGEABLE CLAIMS | 26 minus 20= | * 6 | X$ 9= | | OR | X$18= | 108 |
| INDEPENDENT CLAIMS | 6 minus 3 = | * 3 | X42= | | OR | X84= | 252 |
| MULTIPLE DEPENDENT CLAIM PRESENT | | ☐ | +140= | | OR | +280= | 280 |
| | | | TOTAL | | OR | TOTAL | 1390 |

* If the difference in column 1 is less than zero, enter "0" in column 2

## CLAIMS AS AMENDED - PART II

### AMENDMENT A

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | SMALL ENTITY RATE | ADDITIONAL FEE | OR | OTHER THAN SMALL ENTITY RATE | ADDITIONAL FEE |
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| Total | * 9 | Minus | ** 26 | = | X$ 9= | | OR | X$18= | |
| Independent | * 2 | Minus | *** 6 | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT B

9/16/04

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | RATE | ADDITIONAL FEE | OR | RATE | ADDITIONAL FEE |
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| Total | * 11 | Minus | ** 26 | = | X$ 9= | | OR | X$18= | |
| Independent | * 2 | Minus | *** 6 | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

### AMENDMENT C

2.11.05

| | (Column 1) CLAIMS REMAINING AFTER AMENDMENT | | (Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR | (Column 3) PRESENT EXTRA | RATE | ADDITIONAL FEE | OR | RATE | ADDITIONAL FEE |
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| Total | * 11 | Minus | ** 26 | = | X$ 9= | | OR | X$18= | |
| Independent | * 2 | Minus | *** 6 | = | X42= | | OR | X84= | |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM | | | | ☐ | +140= | | OR | +280= | |
| | | | | | TOTAL ADDIT. FEE | | OR | TOTAL ADDIT. FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 1/03)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 03/07/2005

FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | |

DATE MAILED: 03/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

PACE-037482

5P

| **Advisory Action Before the Filing of an Appeal Brief** | **Application No.** | **Applicant(s)** | |
|---|---|---|---|
| | *10/379,264* | CLIPSTONE ET AL. | |
| | **Examiner** | **Art Unit** | |
| | Stephen Choi | 3724 | |

*--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

THE REPLY FILED 11 February 2005 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires ______months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The reply was filed after the date of filing a Notice of Appeal, but prior to the date of filing an appeal brief. The Notice of Appeal was filed on ______. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a)☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b)☐ They raise the issue of new matter (see NOTE below);
   (c)☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d)☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: ______. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): ______.
6. ☐ Newly proposed or amended claim(s) ______ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: ______.
   Claim(s) objected to: ______.
   Claim(s) rejected: ______.
   Claim(s) withdrawn from consideration: ______.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
12. ☐ Note the attached Information Disclosure Statement(s). (PTO/SB/08 or PTO-1449) Paper No(s). ______
13. ☐ Other: ______.

SC

STEPHEN CHOI
PRIMARY EXAMINER



pw

PACE-037483

Applicants contend that a person of ordinary skill in the art would not be led to incorporate the teachings of Wang on the device of Goel to arrive at the claimed invention since Wang teaches an interlayer and Goel requires a glass-like silica network for provind good adherence. The examiner agrees that Wang does teach that an interlayer is preferred;however, Wang does not teach away from not having interlayer. The statement on Col. 4, lines 4-8 of Wang simply states that the interlayer further enhances adhesion. Furthermore, Wang teaches the DLC doped with chromium provides good adhesion without the glass-like silica network. Thus, a person of ordinary skill in the art would not include a glass-like silica network in the DLC coating taught by Wang when the device of Goel is modifed.

OIPE JC11
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PATENT & TRADEMARK OFFICE

ZZY AF 3724

Attorney's Docket No.: 00216-607001 / Case 8104

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | | |
|---|---|---|---|
| Applicant : Colin Clipstone et al. | | Art Unit : 3724 | |
| Serial No. : 10/379,264 | | Examiner : Stephen Choi | |
| Filed : March 4, 2003 | | | |
| Title : RAZOR BLADE | | | |

**MAIL STOP AF**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

NOTICE OF APPEAL

Applicant hereby appeals to the Board of Patent Appeals and Interferences from the action dated December 16, 2004, finally rejecting claims 2, 4-6, 9-11, 13, and 22-24.

A check in the amount of $500 for the appeal fee is enclosed. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: March 15, 2005

Robert C. Nabinger
Reg. No. 33,431

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

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03/18/2005 HALI11 00000029 10379264
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CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

March 15, 2005
Date of Deposit

Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

O I P E
MAY 16 2005
PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 00216-607001 / Case 8104

AF

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003
Title : RAZOR BLADE

Art Unit : 3724
Examiner : Stephen Choi

**Mail Stop Appeal Brief - Patents**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BRIEF ON APPEAL

Applicants are appealing the final rejection of claims 2, 4-6, 9-11, 13, and 22-24 in the office action dated December 16, 2004. Applicants request that the rejection be reversed. A notice of appeal was filed on March 15, 2005.

**(1) Real Party in Interest**

The real party in interest is The Gillette Company, Prudential Tower Building, Boston, Massachusetts.

**(2) Related Appeals and Interferences**

There are no related appeals or interferences.

**(3) Status of Claims**

Claims 2, 4, 5, 11, 13, 22, and 23 are pending and stand rejected under 35 U.S.C. § 103(a) over Goel et al., U.S. Pat. 5,795,648 ("Goel") in view of Wang, U.S. Pat. 6,731,332 ("Wang").

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

May 13, 2005
Date of Deposit

Sherry L. Hunt
Signature

Sherry L. Hunt
Typed or Printed Name of Person Signing Certificate

05/17/2005 MAHMED1 00000041 10379264
01 FC:1402 500.00 OP

PACE-037486

Claims 6, 9, 10, and 24 are pending and stand rejected under 35 U.S.C. § 103(a) over Goel and Wang and further in view of Clipstone et al., U.S. Pat. 6,684,513 ("Clipstone").

(4) **Status of Amendments**

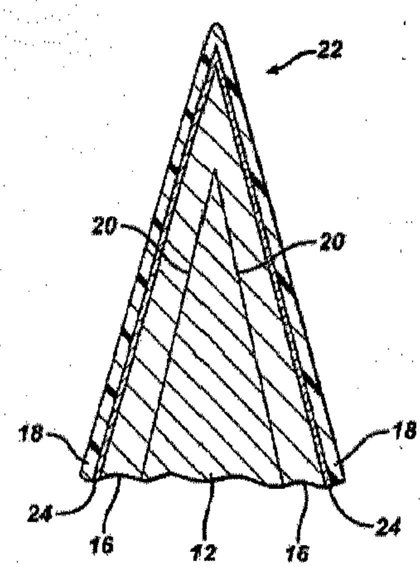
All amendments have been entered.

(5) **Summary of Claimed Subject Matter**

Claims 2 and 13 are independent. Claim 2 generally relates to a razor blade including (1) a substrate with a cutting edge; (2) a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon ("DLC"), diamond, and amphorous diamond, doped with chromium ("Cr") or a Cr alloy; and (3) a coating of polytetrafluoroethylene ("PTFE") on the coating of carbon-containing material. There is no interlayer between the coating of carbon-containing material and the cutting edge.

An embodiment of a razor blade covered by claim 1 is illustrated in Fig. 3 in the application:

**FIG. 3**



Referring to Fig. 3, the razor blade includes substrate 12, a coating 16 consisting of a carbon-containing material (for example, DLC) doped with Cr or a Cr alloy, overcoat layer 24 (not required by claim 2), and a PTFE layer 18. See page 4, lines 19-21.

The razor blade in Fig. 3 does not include an interlayer between the cutting edge of substrate 12 and coating 16 of the carbon-containing material. An interlayer often is included between the substrate and hard carbon coatings such as DLC in commercial razor blades to aid the adherence of the coating to the substrate. See page 1, lines 11-12. Doping the carbon-containing material with Cr or a Cr alloy improves the adhesion of the coating to the substrate and avoids the need for an interlayer (page 5, lines 6-9):

> Hard carbon layer 16, which is doped with chromium, adheres to substrate 12 even though the hard carbon layer is deposited directly on the substrate, without an interlayer. It is believed that the presence of the chromium dopant aids in the adhesion between the hard carbon layer and the cutting edge.

Claim 13 relates to a shaving razor including the razor blade from claim 2.

**(6) Grounds of Rejection to be Reviewed on Appeal**

Applicants request reversal of the 35 U.S.C. § 103(a) rejection of claims 2, 4, 5, 11, 13, 22, and 23 based on the combination Goel and Wang.

Applicants also request reversal of the 35 U.S.C. § 103(a) rejection of claims 6, 9, 10, and 24 based on the combination of Goel, Wang, and Clipstone.

**(7) Argument**

Applicants first will discuss Goel and Wang, and then will explain why the rejection of claim 2 should be reversed.

**Goel**

Goel describes the following razor blade:

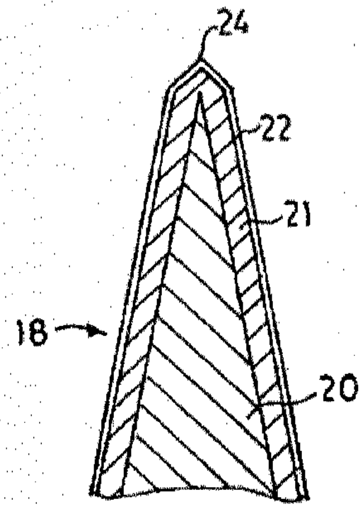



FIG.5

Razor blade 18 in Fig. 5 includes a substrate 20 with a cutting edge 24 having a diamond-like nanocomposite ("DLN") coating 21 and an outer PTFE layer 22. The DLN coating includes a hard carbon material and a glass-like silica network. Goel calls this a "two-component network". See col. 4, lines 25-31 and 63-66. That network may further be doped with a dopant network to provide a three-component network. See col. 4, line 41 - col. 5, line 6, and col. 5, line 29.

The glass-like silica network is a crucial component of the DLN coating. Goel emphasizes that combining the glass-like silica network with the carbon material provides a coating that adheres much better to substrates than carbon coatings not including the glass-like silica network. Goel explains why (col. 5, line 65 - col. 6, line 5):

> The presence of the glass-like silicon network, stabilized by oxygen, serves to prevent the growth of graphitic carbon at high temperatures, to prevent metal cluster formation in metal-containing three-network nanocomposites, and reduce the internal stress in the nanocomposite structure and thereby enhance the adhesion to substrates. This appears to lead to superior adherence of the DLNs of the present invention to the substrate material.

Goel subsequently explains that the enhanced adherence provided by the glass-like silica network avoids the need for an interlayer between the substrate and the DLN coating (col. 6, lines 6-16, emphasis added):

> As already mentioned, to improve adherence of coatings, DLC coatings often require an intermediate layer between the substrate and the DLC coating. Often, if the DLC coatings are too thick, delamination occurs. Surprisingly, with the DLN coatings of the present invention, adherence is so good that an interlayer is usually not required. <u>As a result, the DLN coating may be applied directly to the substrate, and more thickly, without risking delamination from the substrate The ability to apply a thicker layer of DLN coating results from the low intrinsic stress due to the Si-O network, and is believed to contribute to the superior erosion resistance of the DLN-coated substrates.</u>

Goel also touts the enhanced high temperature stability of DLN coatings. According to Goel, DLN materials have temperature stability "far exceeding" DLC materials (see col. 6, lines 32-44) because the DLN materials include the glass-like silica network (col. 6, lines 45-55):

> Further, in the range of from about 600°C. to about 1000°C., the chemical bonds of the carbon matrix of DLN materials partly change from $sp^3$ to $sp^2$. However, the general structure of the nanocomposite and their "diamond-like" properties are preserved. By contrast, under similar conditions, the usual "diamond-like" carbon (DLC) is graphitized and loses its diamond-like properties. In the range of from 400°C. to 500°C. (preferably 430°C.), a reverse transition is observed, whereby the ratio of $sp^3$ to $sp^2$ is increased. It is believed that a varying percentage of the carbon in the DLNs is $sp^3$ bonded carbon.

The dopant is an optional ingredient of the DLN coating. See. e.g., col. 2, lines 41-47 (DLN coating "optionally" includes dopant network) and col. 11, lines 34-35 (DLN coating "optionally" includes a dopant). The dopant is used "to optimize compatibility and adherence" of the DLN coating. See col. 6, lines 21-24. However, Goel explains that the properties of the DLN coating can be optimized even without the addition of a dopant. See col. 6, lines 26-29.

Although Goel describes a razor blade lacking an interlayer between the substrate and a DLN coating, that razor blade differs from the razor blade covered by claim 2 because the DLN coating does not "consist of" a carbon-containing material and a Cr or Cr alloy dopant. The DLN coating further includes the crucial glass-like silica network.

Goel does not suggest that the glass-like silica network can be removed from the DLN coating. In fact, Goel teaches the opposite. The glass-like silica network allows the DLN

coating to adhere adequately to a substrate without the use of an interlayer, provides the DLN coating with improved temperature resistance, and prevents undesirable cluster formation when the DLN material also includes a metal dopant. A person of ordinary skill in the art, reading Goel, would understand that the DLN coating must include the glass-like silica network in order to obtain the beneficial properties described by Goel.

**Wang**

Wang describes a method of depositing DLC coatings on substrates such as semi-conductors, optics, and wear-resistant mechanical components. See col. 4, lines 32-35. Wang does not describe a razor blade, or for that matter any product including a cutting edge. The DLC may be doped with Cr. Wang explains that the doped DLC coating (col. 4, lines 4-8, emphasis added)

> possesses good adhesion to substrate and reduced residual stress <u>especially with the aid of one or more interlayers of metal, metal nitride, or metal carbide</u> formed on the substrate before the formation of DLC film

Thus, Wang stresses that an interlayer should be used to achieve good adherence for a doped DLC coating on wear-resistant mechanical components.

**The Rejection of Claim 2**
**<u>Should Be Reversed</u>**

The rejection of claim 2 under 35 U.S.C. § 103(a) based on the combination of Goel and Wang should be reversed. The rejection is a classic improper hindsight reconstruction of the claimed invention from the prior art, and does not even make technical sense based on the plain teachings of Goel and Wang.

35 U.S.C. § 103(a) provides in relevant part:

> (a) A patent may not be obtained... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

In order to find a claim obvious under 35 U.S.C. § 103(a), there must be a suggestion in the prior art to combine or modify the prior art to obtain the subject matter covered by the claim. See, for example, in <u>In re Oetiker</u>, 977 F.2d 1443, 1447 (Fed. Cir. 1992), in which the Court stated:

> There must be some reason, suggestion, or motivation found in the prior art whereby a person of ordinary skill in the field of the invention would make the combination.

The Federal Circuit has cautioned repeatedly that the suggestion or motivation required for obviousness cannot derive from a hindsight reconstruction of the claimed invention that uses the claim as a roadmap for establishing obviousness. For example, in In re Fritch, 972 F.2d 1260, 1266 (Fed. Cir. 1992), the Court cautioned:

> [I]t is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious....

Similarly, in W.L. Gore and Associates v. Garlock, Inc., 721 F.2d 1540, 1553 (Fed. Cir. 1983) the Court explained:

> To imbue one of ordinary skill in the art with knowledge of the invention when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.

Neither Goel nor Wang, alone or in combination, would motivate a person of ordinary skill in the art to make a razor blade including a substrate having a coating consisting of a carbon-containing material (for example, DLC) doped with Cr or a Cr alloy without an interlayer.[1] Goel teaches that a glass-like silica network should be combined with a carbon material to provide a special DLN coating that can adhere to a razor blade substrate without an interlayer. Goel also touts the other important properties provided by the glass-like silica network, including good high temperature stability and resistance to cluster formation. Wang teaches that an interlayer should be used to obtain good adherence of a doped DLC coating on wear-resistant mechanical components.

A person of ordinary skill in the art, reading Goel and Wang, would not be motivated to remove the glass-like silica network from the DLN coating used by Goel. In fact, the opposite is true -- based on Goel, with or without Wang, a person of ordinary skill in the art would

---

[1]Applicants do not concede that it is even appropriate to combine Wang with Goel in designing a razor blade; Wang has nothing to do with razor blades or any product including a cutting edge. However, claim 2 is not even remotely suggested even if Goel and Wang are combined and applicants have chosen to focus on this argument.

understand that the glass-like silica network has to be included in the DLN coating to obtain good adherence to a razor blade substrate without using an interlayer. Thus, Goel and Wang actually teach away from the razor blade covered by claim 2. See Monarch Knitting Machinery Corp. v. Fukuhara Industrial & Trading Co., 139 F.3d 877, 885 (Fed. Cir. 1998) (quoting In re Gurley, 27 F.3d 551, 553 (Fed. Cir. 1994) ("A prior art reference may be considered to teach away when 'a person of ordinary skill... would be led in a direction divergent from the path that was taken by applicant.'").

Therefore, the 35 U.S.C. § 103(a) rejection of claim 2 based on Goel and Wang should be reversed.

**Remaining Claims**

the 35 U.S.C. § 103(a) rejection of the remaining claims should be reversed for at least the same reasons the 35 U.S.C. § 103(a) rejection of claim 2 should be reversed.

**(7) Conclusion**

The 35 U.S.C. § 103(a) rejection should be reversed.

An appendix listing the claims on appeal follows.

The brief fee of $500 is enclosed. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: May 13, 2005

Tu N. Nguyen Reg. No. 42,934 for
Robert C. Nabinger
Reg. No. 33,431

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21082182.doc

**Appendix of Claims**

2. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond, doped with chromium or an alloy of chromium, on the cutting edge, the coating including from 0.1 to 10 atomic percent chromium; and

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating consisting of the carbon-containing material and the cutting edge.

4. The razor blade of claim 2, wherein the coating consisting of the carbon-containing material includes from 1 to 5 atomic percent chromium.

5. The razor blade of claim 2, wherein the carbon-containing material is diamond-like carbon.

6. The razor blade of claim 2, wherein the carbon-containing material is amphorous diamond.

9. The razor blade of claim 2, further comprising an overcoat layer between the coating consisting of the carbon-containing material and the coating of polytetrafluoroethylene.

10. The razor blade of claim 9, wherein the overcoat layer comprises chromium.

11. The razor blade of claim 2, wherein the coating consisting of the carbon-containing material has a thickness less than 2,000 angstroms and the coating of polytetrafluoroethylene has a thickness between 100 and 5,000 angstroms.

13. A shaving razor comprising:

a handle;

a housing connected to the handle; and

at least one razor blade mounted in the housing, the razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon,

diamond, and amphorous diamond doped with chromium or an alloy of chromium on the cutting edge, and a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating of a carbon-containing material and the cutting edge.

22. The shaving razor of claim 13, wherein the coating consisting of a carbon-containing material includes from 1 to 5 atomic percent chromium.

23. The shaving razor of claim 13, wherein the carbon-containing material is diamond-like carbon.

24. The shaving razor of claim 13, wherein the carbon-containing material is amphorous diamond.

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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 07/28/2005

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| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | |

DATE MAILED: 07/28/2005

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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/379,264
Filing Date: March 04, 2003
Appellant(s): CLIPSTONE ET AL.

MAILED
JUL 2 8 2005
Group 3700

Robert C. Nabinger
For Appellant

**EXAMINER'S ANSWER**

This is in response to the appeal brief filed 16 May 2005.

***(1) Real Party in Interest***

A statement identifying the real party in interest is contained in the brief.

***(2) Related Appeals and Interferences***

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

***(3) Status of Claims***

The statement of the status of the claims contained in the brief is correct.

***(4) Status of Amendments***

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

***(5) Summary of Claimed Subject Matter***

The summary of claimed subject matter contained in the brief is correct.

***(6) Grounds of Rejection to be Reviewed on Appeal***

The appellant's statement of the grounds of rejection to be reviewed on appeal in the brief is correct.

***(7) Claims Appealed***

The copy of the appealed claims contained in the Appendix to the brief is correct.

***(8) Prior Art of Record***

| | | |
|---|---|---|
| 5,795,648 | GOEL et al. | 8-1998 |
| 6,331,332 | WANG | 12-2001 |
| 6,684,513 | CLIPSTONE et al. | 2-2004 |

***(9) Grounds of Rejection***

The following ground(s) of rejection are applicable to the appealed claims:

**Claims 2, 4-5, 11, 13, and 22-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Goel et al. (US 5,795,648) in view of Wang (US 6,331,332).**

Goel discloses the invention substantially as claimed except for a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorus diamond. Instead, Goel teaches use of a coating including DLN materials doped with chromium wherein the coating includes 0.1 to 10 atomic percent chromium. Wang teaches a coating of DLC doped with chromium to provide good adhesion. It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a coating of DLC doped with chromium as taught by Wang in lieu of DLN materials doped with chromium of Goel as an alternative coating to improve preservation of edges on a substrate with good adherence to the substrate. Regarding claims 4 and 22, see col. 5, lines 34-54 of Goel. Regarding claim 11, col. 3, lines 34-43 and col. 4, lines 14-16.

**Claims 6, 9-10, and 24 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Goel in view of Wang, as applied to claims 2 and 13 above, and further in view of Clipstone et al. (US 6,684,513).**

The modified device of Goel discloses the invention substantially as claimed except for an overcoat layer comprising chromium. Clipstone discloses an overcoat layer comprising chromium. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the modified blade of Goel with the overcoat chromium layer as taught by Clipstone in order to provide improved adhesion

of PTFE layer. Regarding claims 6 and 24, the modified device of Goel fails to disclose the carbon-containing material is amphorous diamond. However, Clipstone teaches amphorous diamond is one type of carbon containing materials used for hard coating. It would have been obvious to one having ordinary skill in the art at the time the invention was made to select amphorous diamond as an alternative hard coating material on the modified device of Goel.

***(10) Response to Argument***

Appellants contend that neither Goel nor Wang, alone or in combination, would motivate a person of ordinary skill in the art to make a razor blade as claimed since Goel teaches that a glass-like silica network should be combined with a carbon material to provide a special DLN coating that can adhere without an interlayer and Wang teaches that an interlayer should be used to obtain good adherence of a doped DLC coating. Appellants, therefore, argue that Goel and Wang teach away from the razor blade covered by claim 2 and the examiner's conclusion of obviousness is based upon improper hindsight reasoning even if Goel and Wang can be combined.

The examiner respectfully disagrees. Goel teaches the use of a hard coating layer made from carbon containing diamond-like materials to provide corrosion and wear resistance as well as providing good adherence to a substrate without the interlayer by combining the glass-like silicon network which reduces the internal stress and thereby enhance the adhesion of the coating to the substrate. Wang teaches the use of a hard coating layer made from carbon containing diamond-like materials to provide corrosion and wear resistance. Wang further teaches a process that provides

the carbon containing diamond-like materials being doped with chromium to reduce residual stress to provide good adherence to a substrate. Although Wang teaches that the interlayer may be used to enhance the adhesion, Wang does not teach away from not having interlayer. The statement on Col. 4, lines 4-8 of Wang simply states that the interlayer further enhances adhesion. Wang further teaches the DLC doped with chromium provides good adhesion without the glass-like silica network as taught by Goel. A person of ordinary skill in the art would not include a glass-like silica network in the DLC coating taught by Wang when the device of Goel is modifed. Thus, combining the teachings of Goal and Wang would provide a razor blade with a hard coating layer consisting of a carbon-containing material doped with chromium without the interlayer as claimed in claim 2.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

STEPHEN CHOI
PRIMARY EXAMINER

sc
July 21, 2005

Conferees

Allan Shoap

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Attorney's Docket No.: 00216-607001
Client's Ref. No.: Case 8104

# OFFICIAL COMMUNICATION FACSIMILE:

## OFFICIAL FAX NO: (571) 273-8300

**Number of pages including this page** 13

Applicant : Colin Clipstone et al.
Serial No. : 10/379,264
Filed : March 4, 2003

Art Unit : 3724
Examiner : Stephen Choi

Title : Razor Blade

**Attn: Tina Lee**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Attached to this facsimile communication cover sheet is Revised Brief on Appeal, faxed this 15thday of November, 2005, to the United States Patent and Trademark Office.

Respectfully submitted,

Date: November 15, 2005

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## Evidence Appendix

None.

**Related Proceeding Appendix**

None.

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FISH & RICHARDSON PC
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Paper No:
Appeal No: 2006-0263
Application: 10/379,264
Appellant: Colin Clipstone et al.

# Board of Patent Appeals and Interferences
# Docketing Notice

Application 10/379,264 was received from the Technology Center at the Board on November 04, 2005 and has been assigned Appeal No: 2006-0263.

A review of the file indicates that the following documents have been filed by appellant:

| | |
|---|---|
| Appeal Brief filed on: | May 16, 2005 |
| Reply Brief filed on: | NONE |
| Request for Hearing filed on: | NONE |

In all future communications regarding this appeal, please include both the application number and the appeal number.

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The facsimile number of the Board is 571-273-0052. Because of the heightened security in the Washington D.C. area, facsimile communications are recommended. Telephone inquiries can be made by calling 571-272-9797 and should be directed to a Program and Resource Administrator.

By order of the Board of Patent Appeals and Interferences

The opinion in support of the decision being entered today was not written for publication in a law journal and is not binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

MAILED
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AND INTERFERENCES

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*Ex parte* COLIN CLIPSTONE, STEVE S. HAHN, XIQIAN ERIC LIU, NEVILLE SONNENBERG and ANDREW ZHUK

---

Appeal No. 2006-0263
Application No. 10/379,264

---

ON BRIEF

---

Before KIMLIN, OWENS and JEFFREY T. SMITH, Administrative Patent Judges.

KIMLIN, Administrative Patent Judge.

## DECISION ON APPEAL

This is an appeal from the final rejection of claims 2, 4-6, 9-11, 13 and 22-24. Claim 2 is illustrative:

2. A razor blade, comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets;

a coating consisting of a carbon-containing material selected from the group consisting of diamond-like carbon, diamond, and amphorous diamond, doped with chromium or an alloy of chromium, on the cutting edge, the coating including from 0.1 to 10 atomic percent chromium; and



PACE-037507

a coating of polytetrafluoroethylene on the coating of a carbon-containing material;

wherein there is no interlayer between the coating consisting of the carbon-containing material and the cutting edge.

The examiner relies upon the following references as evidence of obviousness:

| | | |
|---|---|---|
| Goel et al. (Goel) | 5,795,648 | Aug. 18, 1998 |
| Wang | 6,331,332 | Dec. 18, 2001 |
| Clipstone et al. (Clipstone) | 6,684,513 | Feb. 3, 2004 (filed Feb. 29, 2000) |

Appellants' claimed invention is directed to a razor blade comprising a coating consisting of a carbon-containing material, e.g., a diamond-like carbon, and chromium as a dopant. The appealed claims set forth that there is no interlayer between the coating and the cutting edge of the razor blade.

Appealed claims 2, 4, 5, 11, 13, 22 and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Goel in view of Wang. Claims 6, 9, 10 and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over the stated combination of references further in view of Clipstone.

Appellants have not set forth an argument that is reasonably specific to any particular claim on appeal. Accordingly, all the appealed claims stand or fall together with claim 2. Also, we



PACE-037508

note that appellants have not set forth a separate substantive argument for the separate § 103 rejection of claims 6, 9, 10 and 24.

We have thoroughly reviewed each of appellants' arguments for patentability. However, we are in complete agreement with the examiner that the claimed subject matter would have been obvious to one of ordinary skill in the art within the meaning of § 103 in view of the applied prior art. Accordingly, we will sustain the examiner's rejections.

There is no dispute that Goel, like appellants, discloses a razor blade comprising a cutting edge and a coating comprising a carbon-containing material, i.e., a diamond-like carbon and a chromium dopant, with no interlayer between the carbon-containing material and the cutting edge of the blade. Goel also teaches that the coating comprises a silicon network that interpenetrates the diamond-like carbon material network. However, inasmuch as the BACKGROUND section of Goel evidences that it was known in the art to use coatings of diamond-like materials for razor blades, we are satisfied that it would have been obvious for one of ordinary skill in the art to eliminate the silicon network of Goel along with its described advantages. It is well settled that the omission of a feature disclosed by the prior art along



PACE-037509

with its attendant function is a matter of obviousness for one of ordinary skill in the art. In re Thompson, 545 F.2d 1290, 1294, 192 USPQ 275, 277 (CCPA 1976); In re Kuhle, 526 F.2d 553, 555, 188 USPQ 7, 9 (CCPA 1975); In re Edge, 359 F.2d 896, 899, 149 USPQ 556, 557 (CCPA 1966). As for the presence of the chromium dopant in the coating layer, Goel, as well as Wang, provide evidence that it was known in the art to employ such chromium dopants in the coatings of razor blades which comprise diamond-like materials. Although Wang is not directed to razor blades, in particular, appellants acknowledge that Wang discloses that a diamond-like carbon material containing chromium possesses good adhesion to a substrate (column 4, lines 4 et seq.). The fact that Wang also teaches that the provision of interlayers may especially enhance the adhesion and reduced residual stress of a chromium-containing diamond-like carbon material does not negate the fact that the reference explicitly teaches that the presence of chromium improves the adhesion of a diamond-like carbon material. Appellants have not argued, let alone provided objective evidence, that the adhesion of the claimed coating material cannot be increased by providing an interlayer.

As a final point, we note that appellants base no argument upon objective evidence of nonobviousness, such as unexpected



PACE-037510

results, which would serve to rebut the inference of obviousness established by the applied prior art.

In conclusion, based on the foregoing, the examiner's decision rejecting the appealed claims is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a)(1)(iv) (effective Sep. 13, 2004; 69 Fed. Reg. 49960 (Aug. 12, 2004); 1286 Off. Gaz. Pat. Office 21 (Sep. 7, 2004)).

AFFIRMED

Edward C Kimlin
EDWARD C. KIMLIN
Administrative Patent Judge

Terry J. Owens
TERRY J. OWENS
Administrative Patent Judge

JEFFREY T. SMITH
Administrative Patent Judge

BOARD OF PATENT APPEALS AND INTERFERENCES

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PACE-037511

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PACE-037512

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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/379,264 | 03/04/2003 | Colin Clipstone | 00216-607001 | 7124 |

26161 7590 04/07/2006

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| EXAMINER | |
|---|---|
| CHOI, STEPHEN | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 3724 | |

DATE MAILED: 04/07/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

PACE-037513

| Notice of Abandonment | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/379,264 | CLIPSTONE ET AL. | |
| | Examiner | Art Unit | |
| | Stephen Choi | 3724 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--*

This application is abandoned in view of:

1. ☐ Applicant's failure to timely file a proper reply to the Office letter mailed on ______.
   (a) ☐ A reply was received on ______ (with a Certificate of Mailing or Transmission dated ______), which is after the expiration of the period for reply (including a total extension of time of ______ month(s)) which expired on ______.
   (b) ☐ A proposed reply was received on ______, but it does not constitute a proper reply under 37 CFR 1.113 (a) to the final rejection.
   (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114).
   (c) ☐ A reply was received on ______ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
   (d) ☐ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on ______ (with a Certificate of Mailing or Transmission dated ______), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $______ is insufficient. A balance of $______ is due.
   The issue fee required by 37 CFR 1.18 is $______. The publication fee, if required by 37 CFR 1.18(d), is $______.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on ______ (with a Certificate of Mailing or Transmission dated ______), which is after the expiration of the period for reply.
   (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record, the assignee of the entire interest, or all of the applicants.

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34(a)) upon the filing of a continuing application.

6. ☒ The decision by the Board of Patent Appeals and Interference rendered on *18 January 2006* and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☐ The reason(s) below:

**STEPHEN CHOI**
**PRIMARY EXAMINER**

Petitions to revive under 37 CFR 1.137(a) or (b), or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.

# Exhibit 5

# THE AMERICAN HERITAGE® COLLEGE DICTIONARY

THIRD EDITION

HOUGHTON MIFFLIN COMPANY
*Boston • New York*

PACE-037836

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0-395-67161-2 (UPC)

*Library of Congress Cataloging-in-Publication Data*

The American heritage college dictionary. —3rd ed.
p. cm.
ISBN 0-395-66917-0 (plain edge). —ISBN 0-395-44638-4 (thumb edge). —ISBN 0-395-66918-9 (deluxe binding).
1. English language—Dictionaries. 2. Americanisms.
PE1628.A6227 1993
423—dc20 92-42124
CIP

Manufactured in the United States of America

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PACE-037837

monia or ammonium compounds in the
ganic matter.
'ə-fī', ə-mŏ'nə-) tr. & intr.v. -fied, -fy-
ct or be subjected to ammonification.
n.
ĭt') also am•mo•noid (-noid') n. The
an extinct mollusk abundant in the Cre-
t. Ammonītēs < Lat. (cornū) Ammōnis,
ionite, genitive of Ammōn, Amen < Gk.]
ĭt'ĭk) adj.
ĭt') n. 1. A member of an ancient Se-
ast of the Jordan River. 2. The Semitic
monites. [< LLat. Ammonītēs, the Am-
mōnī, Ammonite < 'ammōn, Ammon <
ople, kinsman.] — Am'mon•ite' adj.
ĭ'nē-əm) n. The univalent chemical ion
ammonia. [AMMON(IA) + -IUM.]
ate n. A crystalline salt, $NH_4HCO_3$,
hing compounds and in baking powder.
te n. A salt, a carbonate of ammonium,
is a component of smelling salts.
te n. 1. A carbonate of ammonium,
commercially produced double salt of
onate and ammonium carbamate,
$NH_4$, used in smelling salts.
n. A slightly hygroscopic white crystal-
$Cl$, used in dry cells.
e n. A colorless, basic, aqueous solution
H, used as a cleanser and in the manu-
yon, rubber, fertilizer, and plastic.
A colorless crystalline salt, $NH_4NO_3$,
plosives, and solid rocket propellants.
A brownish-gray to white crystalline
d in fertilizers and water purification.
ate n. A colorless crystalline compound,
yeing fabrics and electroplating.
oid') n. Var. of ammonite.
'yə-nĭsh'ən) n. 1. All projectiles, such as
at can be fired from guns or otherwise
, biological, chemical, or explosive ma-
weapons. 3. An object used as a missile
4. A means of attacking or defending an
point of view. [Obsolete Fr. amunition <
ovisioning, alteration of la munition <
munītiōn-, fortification. See MUNITION.]

an (ăm'nē mə-jĭn' shān). A range of
tral China, rising to 7,164.5 m (23,490

ə) n. Partial or total loss of memory. [Gk.
s, prob. < amnēstia: a-, not; see A-1 +
ember; see men-1*.] — am•ne'si•ac'
k'), am•ne'sic (-zĭk, -sĭk) n. & adj.
'tĭk) adj.
) n., pl. -ties. A general pardon granted
for political offenses. — tr.v. -tied, -ty-
general pardon to. [Lat. amnestia < Gk.
, not remembered : a-, not; see A-1 +
ember; see men-1*.]
(ăm'nē-ō-sĕn-tē'sĭs) n., pl. -ses (-sēz). A
amniotic fluid is drawn out of the uterus
rmine genetic abnormalities in or the sex
mniocentēsis: AMNION + Gk. kentēsis, act
ein, to prick; see kent-*.]
ăm'nē-ŏg'rə-fē) n., pl. -phies. Radio-
of the fetus following injection of a ra-
into the amnion. [AMNIO(N) + -GRAPHY.]
-ŏn') n., pl. -ni•ons or -ni•a (-nē-ə). A
branous sac that encloses the embryo or
bird, or reptile. [Gk. amniōn.] — am'ni•
i•on'ic (-ŏn'ĭk) adj.
'nē-ŏs'kə-pē) n., pl. -pies. Examination
n optical instrument that is inserted di-
otic cavity. [AMNIO(N) + -SCOPY.] — am'-
p') n.
n'ō-băr'bĭ-tăl', -tôl') n. A barbiturate
as a sedative and a hypnotic. [AM(YL) +

•ba (ə-mē'bə) n., pl. -bas or -bae (-bē).
enus Amoeba or related genera having no
oving by means of pseudopods. [NLat.,
amoibē, change < ameibein, to change.]
oe'bic (-bĭk) adj.
n•oe•be•an (ăm'ə-bē'ən) adj. Answer-
rosody. [< LLat. amoebaeus < Gk. a-
change. See AMOEBA.]
'ə-bī'ə-sĭs) n. Var. of amebiasis.
Var. of amebic dysentery.
a•me•bo•cyte (ə-mē'bə-sīt') n. A cell
rm or motion. [AMOEB(A) + -CYTE.]
oid') adj. 1. Of or resembling an amoe-
bility of form and means of locomotion.

2. Having an irregular or asymmetrical shape.
a•mok (ə-mŭk', ə-mŏk') adv. & adj. Var. of amuck.
a•mo•le (ə-mō'lē) n. 1. The root, bulb, or another plant part of several North American plants, such as species of Agave, Chlorogalum, and Yucca, used as a soap. 2. A plant so used. [Am.Sp. < Nahuatl amolli.]
A•mon (ä'mən) n. Myth. Var. of Amen.
a•mong (ə-mŭng') also a•mongst (ə-mŭngst') prep. 1. In the midst of; surrounded by. 2. In the group, number, or class of: She is among the wealthy. 3. In the company of; in association with: traveling among a group of tourists. 4. By many or the entire number of; with many: a custom among the Greeks. 5. By the joint action of: Among us, we will finish. 6. With portions to each of: Distribute this among you. 7. Each with the other: Don't fight among yourselves. See Usage Note at between. [ME < OE amang: ā, in; see A-2 + gemang, throng; see mag-*.]
a•mon•til•la•do (ə-mŏn'tl-ä'dō, -tē-ä'-) n., pl. -dos. A pale dry sherry. [Sp. : a-, to (< Lat. ad-; see AD-) + Montilla, a town of S Spain.]
a•mor•al (ā-môr'əl, ā-mŏr'-) adj. 1. Not admitting of moral distinctions or judgments; neither moral nor immoral. 2. Lacking moral sensibility; not caring about right and wrong. — a•mor'al•ism, a'mo•ral'i•ty (ā'mō-răl'ĭ-tē, -mə-) n. — a•mor'al•ly adv.
am•o•ret•to (ăm'ə-rĕt'ō, ä'mə-) n., pl. -ti (-tē) or -tos. A cupid. [Ital., dim. of Amore, Cupid < Lat. Amor < amor, love. See AMOROUS.]
am•o•rist (ăm'ər-ĭst) n. 1. One dedicated to love, esp. sexual love. 2. One who writes about love. [Lat. amor, love; see AMOROUS + -IST.]
Am•o•rite (ăm'ə-rīt') n. A member of one of several ancient Semitic peoples primarily inhabiting Canaan and Babylonia. [< Heb. 'ĕmōrī, Amorite < Akkadian amurru, westerner, Amorite.] — Am'o•rite' adj.
am•o•rous (ăm'ər-əs) adj. 1. Strongly attracted or disposed to love, esp. sexual love. 2. Indicative of love or sexual desire: an amorous glance. 3. Of or associated with love. 4. Being in love; enamored. [ME < OFr. amoureus < Med.Lat. amōrōsus < Lat. amor, love < amāre, to love.] — am'or•ous•ly adv. — am'or•ous•ness n.
a•mor•phism (ə-môr'fĭz'əm) n. The state or quality of being amorphous.
a•mor•phous (ə-môr'fəs) adj. 1. Lacking definite form; shapeless. 2. Of no particular type; anomalous. 3. Lacking organization; formless. 4. Lacking distinct crystalline structure. [< Gk. amorphos: a-, without; see A-1 + morphē, shape.] — a•mor'phous•ly adv. — a•mor'phous•ness n.
am•or•ti•za•tion (ăm'ər-tĭ-zā'shən, ə-môr'tĭ-) n. 1.a. The act or process of amortizing. b. The money set aside for this purpose. 2. For a bond bought at a premium, the periodic subtraction from its current yield of a proportionate share of the premium between the purchase date and the maturity date.
am•or•tize (ăm'ər-tīz', ə-môr'-) tr.v. -tized, -tiz•ing, -tiz•es. 1. To liquidate (a debt) by installment payments or payment into a sinking fund. 2. To write off an expenditure for (office equipment, for example) by prorating over a certain period. [ME amortisen, to alienate in mortmain < OFr. amortir, amortiss- < VLat. *admortire, to deaden : Lat. ad-, ad- + Lat. mors, mort-, death; see mer-*.] — am'or•tiz'a•ble adj.
A•mos (ā'məs) n. Bible. 1. A Hebrew prophet of the 8th cent. B.C. 2. See table at Bible.
a•mount (ə-mount') n. 1. The total of two or more quantities; the aggregate. 2. A number; a sum. 3. A principal plus its interest. 4. The full effect or meaning; import. 5. Quantity: a great amount. — intr.v. a•mount•ed, a•mount•ing, a•mounts. 1. To add up in number or quantity. 2. To add up in import or effect: That plan will never amount to much. 3. To be equivalent or tantamount: accusations that amount to an indictment. [< ME amounten, to ascend < OFr. amonter < amont, upward < Lat. ad montem, to the hill : ad, to; see ad-* + mōns, mont-, hill; see men-2*.]
a•mour (ə-mo͝or') n. A love affair, esp. an illicit one. [ME < OFr. < OProv. < Lat. amor, love. See AMOROUS.]
a•mour-pro•pre (ä-mo͝or-prôp'rə) n. Respect for oneself; self-esteem. [Fr. : amour, love + propre, own.]
A•moy1 (ä-moi'). See Xiamen.
A•moy2 (ä-moi', ə-moi') n. The dialect of Chinese spoken in and around Xiamen in southeast China. [After Amoy (Xiamen).]
amp (ămp) n. Informal. 1. An ampere. 2. An amplifier.
AMP (ā'ĕm-pē') n. A mononucleotide, $C_{10}H_{14}N_5O_7P$, found in animal cells and reversibly convertible to ADP and ATP; adenosine monophosphate. [A(DENOSINE) M(ONO)P(HOSPHATE).]
am•per•age (ăm'pər-ĭj, ăm'pîr'-) n. The strength of an electric current expressed in amperes.
am•pere (ăm'pîr') n. 1. A unit of electric current in the meter-kilogram-second system, equal to the current that, flowing in two parallel wires one meter apart, produces a force of $2 \times 10^{-7}$ newtons per meter. 2. A unit specified as one International coulomb per second and equal to 0.999835 ampere. See table at measurement. [After André Marie AMPÈRE.]
Am•père (ăm'pîr, äN-pĕr'), André Marie. 1775–1836. French physicist and mathematician.
am•pere-hour (ăm'pîr-our') n. The electric charge transferred by a current of one ampere in one hour.
am•pere-turn (ăm'pîr-tûrn') n. A unit of magnetomotive force in the meter-kilogram-second system equal to the force of one turn of a conducting loop carrying a current of one ampere.
am•per•sand (ăm'pər-sănd') n. The character or sign (&) representing the word and. [Alteration of and per se and, & (the sign) by itself (is the word) and.]
am•phet•a•mine (ăm-fĕt'ə-mēn', -mĭn) n. 1. A colorless volatile liquid, $C_9H_{13}N$, used primarily as a central nervous system stimulant. 2. A derivative of amphetamine, such as dextroamphetamine, used as a central nervous system stimulant. [A(LPHA) + M(ETHYL) + PH(ENYL) + ET(HYL) + AMINE.]
amphi– pref. 1. Both: amphibiotic. 2. On both sides: amphistylar. 3. Around: amphithecium. [Lat. < Gk. < amphi, on both sides, around. See ambhi*.]
am•phi•ar•thro•sis (ăm'fē-är-thrō'sĭs) n., pl. -ses (-sēz). A type of articulation between bony surfaces that permits limited motion and is connected by ligaments or elastic cartilage.
am•phib•i•an (ăm-fĭb'ē-ən) n. 1. A cold-blooded smooth-skinned vertebrate of the class Amphibia that hatches as an aquatic larva with gills and transforms into an adult having air-breathing lungs. 2. An animal capable of living both on land and in water. 3. An aircraft that can take off and land on either land or water. 4. A vehicle that can operate both on land and in water. [< NLat. Amphibia, class name < Gk., neut. pl. of amphibios, amphibious : amphi-, amphi- + bios, life; see gwel-*.]
am•phi•bi•ot•ic (ăm'fə-bī-ŏt'ĭk) adj. Living in water during an early stage of development and on land during the adult stage.
am•phib•i•ous (ăm-fĭb'ē-əs) adj. 1. Biol. Living or able to live on land and in water. 2. Able to operate both on land and in water: amphibious tanks. 3. Relating to or organized for a military landing by naval and land forces. 4. Of a mixed or twofold nature. [< Lat. amphibius < Gk. amphibios. See AMPHIBIAN.] — am•phib'i•ous•ly adv. — am•phib'i•ous•ness n.
am•phi•bole (ăm'fə-bōl') n. Any of a large group of structurally similar hydrated double silicate minerals, such as hornblende. [Fr. < LLat. amphibolus, ambiguous < Gk. amphibolos, doubtful < amphiballein, to throw on either side : amphi-, amphi- + ballein, to throw; see gwelə-*.] — am'phi•bol'ic (-bŏl'ĭk) adj.
am•phib•o•lite (ăm-fĭb'ə-līt') n. A chiefly amphibole rock with minor plagioclase and little quartz. — am•phib'o•lit'ic (-lĭt'ĭk) adj.
am•phib•o•lous (ăm-fĭb'ə-ləs) adj. Having a grammatical structure that allows of two interpretations; equivocal. [< LLat. amphibolus. See AMPHIBOLE.]
am•phi•brach (ăm'fə-brăk') n. A trisyllabic metrical foot having one accented or long syllable between two unaccented or short syllables, as in remember. [Lat. amphibrachys < Gk. amphibrakhus: amphi-, amphi- + brakhus, short; see mregh-u-*.]
am•phic•ty•o•ny (ăm-fĭk'tē-ə-nē) n., pl. -nies. A league of neighboring ancient Greek states sharing a common religious center or shrine, esp. the one at Delphi. [Gk. Amphiktuonia < amphiktuones, var. of amphiktiones, neighbors : amphi-, on the periphery; see AMPHI– + ktizein, to settle; see tkei-*.] — am•phic'ty•on'ic (-ŏn'ĭk) adj.
am•phi•dip•loid (ăm'fĭ-dĭp'loid) adj. Genet. Having a diploid set of chromosomes derived from each parent. — am'phi•dip'loid n. — am'phi•dip'loid•y n.
am•phim•a•cer (ăm-fĭm'ə-sər) n. A trisyllabic metrical foot having an unaccented or short syllable between two accented or long syllables, as in Peter Pan. [Lat. amphimacrus < Gk. amphimakros: amphi-, amphi- + makros, long; see māk-*.]
am•phi•mix•is (ăm'fə-mĭk'sĭs) n., pl. -mix•es (-mĭk'sēz'). The union of the sperm and egg in sexual reproduction. [AMPHI– + Gk. mixis, a mingling (< mignunai, mik-, to mingle; see meik-*).] — am'phi•mic'tic (-mĭk'tĭk) adj.
Am•phi•on (ăm-fī'ən) n. Gk. Myth. The son of Zeus and twin brother of Zethus, with whom he built a wall around Thebes by charming the stones into place with his lyre.
am•phi•ox•us (ăm'fē-ŏk'səs) n. See lancelet. [AMPHI– + Gk. oxus, sharp; see ak-*.]
am•phi•pod (ăm'fə-pŏd') n. A crustacean of the order Amphipoda with a laterally compressed body and no carapace. [< NLat. Amphipoda, order name : AMPHI– + NLat. -poda, -pod.]
am•phip•ro•style (ăm-fĭp'rə-stīl', ăm'fĭ-prō'stīl') adj. Archit. Having a set of columns at each end but none along the sides. [Lat. amphiprostȳlos < Gk. amphiprostulos: amphi-, amphi- + prostulos, with pillars in front; see PROSTYLE.] — am•phip'ro•style' n.
am•phis•bae•na (ăm'fĭs-bē'nə) n. Myth. A serpent having a head at each end of its body. [ME amphibena < Lat. am-




amphipod

| | |
|---|---|
| ă pat | oi boy |
| ā pay | ou out |
| âr care | o͝o took |
| ä father | o͞o boot |
| ĕ pet | ŭ cut |
| ē be | ûr urge |
| ĭ pit | th thin |
| ī pie | th this |
| îr pier | hw which |
| ŏ pot | zh vision |
| ō toe | ə about, |
| ô paw | item |

Stress marks:
' (primary);
' (secondary), as in
dictionary (dĭk'shə-nĕr'ē)

PACE-037838

# Exhibit 6

# McGraw-Hill Dictionary of Scientific and Technical Terms

## Fifth Edition

**Sybil P. Parker**
Editor in Chief

**McGraw-Hill, Inc.**
New York San Francisco Washington, D.C.
Auckland Bogotá Caracas Lisbon London Madrid Mexico City Milan
Montreal New Delhi San Juan Singapore Sydney Tokyo Toronto

PACE-037860

On the cover: Photomicrograph of crystals of vitamin $B_1$.
*(Dennis Kunkel, University of Hawaii)*

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**McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS,**
**Fifth Edition**

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1 2 3 4 5 6 7 8 9 0 DOW/DOW 9 9 8 7 6 5 4 3

ISBN 0-07-042333-4

**Library of Congress Cataloging-in-Publication Data**

McGraw-Hill dictionary of scientific and technical terms /
Sybil P. Parker, editor in chief.—5th ed.
p. cm.
ISBN 0-07-042333-4
1. Science—Dictionaries. 2. Technology—Dictionaries.
I. Parker, Sybil P.
Q123.M34 1993
503—dc20 93-34772
CIP

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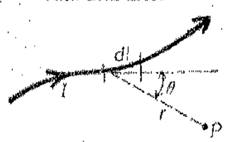
PACE-037861

AMPÈRE LAW




A graphic representation of the Ampère law (def. 1). Contribution of current element to magnetic induction at $P$ is proportional to $I\ dl \sin\theta/r^2$. $I$ = current $dl$ = length of current element, $r$ = distance of point $P$ from current elements, angle $\theta$ is between current element and the line forming the element to point $P$. The contribution points perpendicularly into the page.

spores; they are motile by means of polar flagella. { ə¦mȯr·fə·spə'ran·jəm }

**amorphous** [PHYS] Pertaining to a solid which is noncrystalline, having neither definite form nor structure. { ə'mȯr·fəs }

**amorphous film** [MATER] A magnetically ordered metallic film that can be deposited on a semiconductor chip or on almost any other material without need for a crystal substrate, for use in magnetic bubble memories. { ə'mȯr·fəs 'film }

**amorphous frost** [HYD] Hoar frost which possesses no apparent simple crystalline structure; opposite of crystalline frost. { ə'mȯr·fəs 'frȯst }

**amorphous laser** *See* glass laser. { ə'mȯr·fəs 'lāz·ər }

**amorphous memory array** [COMPUT SCI] An array of memory switches made of amorphous material. { ə'mȯr·fəs 'mem·rē ə,rā }

**amorphous mineral** [MINERAL] A mineral without definite crystalline structure. { ə'mȯr·fəs 'min·rəl }

**amorphous peat** [GEOL] Peat composed of fine grains of organic matter; it is plastic like wet, heavy soil, with all original plant structures destroyed by decomposition of cellulosic matter. { ə'mȯr·fəs 'pēt }

**amorphous ribbon** [MET] A metallic alloy that has an amorphous structure and is formed into a strip 25 to 50 micrometers thick and 1 to 150 millimeters (0.04 to 6 inches) wide, by a process in which a melt of the required composition is ejected through an orifice onto a copper drum where it is instantly quenched and formed into a ribbon by rotation of the drum. { ə'mȯr·fəs 'rib·ən }

**amorphous semiconductor** [SOLID STATE] A semiconductor material which is not entirely crystalline, having only short-range order in its structure. { ə'mȯr·fəs ¦sem·ē·kən¦dək·tər }

**amorphous sky** [METEOROL] A sky characterized by an abundance of fractus clouds, usually accompanied by precipitation falling from a higher, overcast cloud layer. { ə'mȯr·fəs 'skī }

**amorphous snow** [HYD] A type of snow with irregular crystalline structure. { ə'mȯr·fəs 'snō }

**amorphous solid** [SOLID STATE] A rigid material whose structure lacks crystalline periodicity; that is, the pattern of its constituent atoms or molecules does not repeat periodically in three dimensions. { ə'mȯr·fəs 'säl·əd }

**amortisseur winding** *See* damper winding. { a¦mȯrd·ə¦sər 'wīnd·iŋ }

**amortize** [IND ENG] To reduce gradually an obligation, such as a mortgage, by periodically paying a part of the principal as well as the interest. { 'am·ər,tīz }

**amortizement** [ARCH] The sloping top of a buttress or projecting pier. { ¦am·ər¦tīz·mənt }

**amosite** [MINERAL] A monoclinic amphibole form of asbestos having long fibers and a high iron content; used in insulation. { 'am·ə,zīt }

**amount limit** [IND ENG] In a test for a fixed quantity of work, the time required to complete the work or the total amount of work that can be completed in an unlimited time. { ə'maunt ,lim·ət }

**amount of substance** [CHEM] A measure of the number of elementary entities present in a substance or system; usually measured in moles. { ə'maunt əv 'səb·stəns }

**amp** *See* amperage; ampere. { amp }

**AMP** *See* adenylic acid.

**3′,5′-AMP** *See* cyclic adenylic acid.

**ampacity** [ELEC] Current-carrying capacity in amperes; used as a rating for power cables. { am'pas·əd·ē }

**ampangabeite** *See* samarskite. { ,äm,päŋ'gä·bē,īt }

**Ampeliscidae** [INV ZOO] A family of tube-dwelling amphipod crustaceans in the suborder Gammaridea. { ,am·pə'lis·ə,dē }

**ampelite** [PETR] A graphite schist containing silica, alumina, and sulfur; used as a refractory. { 'am·pə,līt }

**amperage** [ELEC] The amount of electric current in amperes. Abbreviated amp. { 'am·prij }

**ampere** [ELEC] The unit of electric current in the rationalized meter-kilogram-second system of units; defined in terms of the force of attraction between two parallel current-carrying conductors. Abbreviated a; A; amp. { 'am,pir }

**Ampère balance** *See* current balance. { 'äm,per ,bal·əns }

**Ampère currents** [ELECTROMAG] Postulated "molecular-ring" currents to explain the phenomena of magnetism as well as the apparent nonexistence of isolated magnetic poles. { 'äm,per 'kər·əns }

**ampere-hour** [ELEC] A unit for the quantity of electricity, obtained by integrating current flow in amperes over the time in hours for its flow; used as a measure of battery capacity. Abbreviated Ah; amp-hr. { 'am,pir ¦au̇·ər }

**ampere-hour capacity** [ELEC] The charge, measured in ampere-hours, that can be delivered by a storage battery up to the limit to which the battery may be safely discharged. { 'am,pir ¦au̇·ər kə'pas·əd·ē }

**ampere-hour meter** [ENG] A device that measures the total electric charge that passes a given point during a given period of time. { 'am,pir ¦au̇·ər ,mēd·ər }

**Ampère law** [ELECTROMAG] **1.** A law giving the magnetic induction at a point due to given currents in terms of the current elements and their positions relative to the point. Also known as Laplace law. **2.** A law giving the line integral over a closed path of the magnetic induction due to given currents in terms of the total current linking the path. { 'äm,per ,lȯ }

**ampere meter squared** [ELECTROMAG] The SI unit of electromagnetic moment. Abbreviated $Am^2$. { ¦am,pir ¦mēd·ər 'skwerd }

**ampere-minute** [ELEC] A unit of electrical charge, equal to the charge transported in 1 minute by a current of 1 ampere, or to 60 coulombs. Abbreviated A min. { ¦am,pir ¦min·ət }

**ampere per meter** [ELECTROMAG] The SI unit of magnetic field strength and magnetization. Abbreviated A/m. { 'am,pir pər 'mēd·ər }

**ampere per square inch** [ELEC] A unit of current density, equal to the uniform current density of a current of 1 ampere flowing through an area of 1 square inch. Abbreviated $A/in^2$. { 'am,pir pər ,skwer 'inch }

**ampere per square meter** [ELEC] The SI unit of current density. Abbreviated $A/m^2$. { 'am,pir pər ,skwer 'mēd·ər }

**Ampère rule** [ELECTROMAG] The rule which states that the direction of the magnetic field surrounding a conductor will be clockwise when viewed from the conductor if the direction of current flow is away from the observer. { 'äm,per ,rül }

**ampere square meter per joule second** [ELECTROMAG] The SI unit of gyromagnetic ratio. Abbreviated $Am^2/Js$. { ¦am,pir ¦skwer ¦mēd·ər pər ¦jül 'sek·ənd }

**Ampère theorem** [ELECTROMAG] The theorem which states that an electric current flowing in a circuit produces a magnetic field at external points equivalent to that due to a magnetic shell whose bounding edge is the conductor and whose strength is equal to the strength of the current. { 'äm,per ,thir·əm }

**ampere-turn** [ELECTROMAG] A unit of magnetomotive force in the meter-kilogram-second system defined as the force of a closed loop of one turn when there is a current of 1 ampere flowing in the loop. Abbreviated amp-turn. { 'am,pir ,tərn }

**amperometric titration** [PHYS CHEM] A titration that involves measuring an electric current or changes in current during the course of the titration. { ¦am·pə·rə¦me·trik tī'trā·shən }

**amperometric transducer** [ENG] A transducer in which the concentration of a dissolved substance is determined from the electric current produced between two electrodes immersed in the test solution when one of the electrodes is kept at a selected electric potential with respect to the solution. { am,pir·ə¦me·trik tranz'dü·sər }

**amperometry** [PHYS CHEM] Chemical analysis by techniques which involve measuring electric currents. { ,am·pə'rä·mə·trē }

**Ampharetidae** [INV ZOO] A large, deep-water family of polychaete annelids belonging to the Sedentaria. { ,am·fə'red·ə,dē }

**Ampharetinae** [INV ZOO] A subfamily of annelids belonging to the family Ampharetidae. { ,am·fə'ret·ə,nē }

**amphetamine** [PHARM] $C_6H_5CH_2CHNHCH_3$ A volatile, colorless liquid used as a central nervous system stimulant. { ,am'fed·ə,mēn }

**amphiarthrosis** [ANAT] An articulation of limited movement in which bones are connected by fibrocartilage, such as that between vertebrae or that at the tibiofibular junction. { ,am·fī·är'thrō·səs }

**amphiaster** [INV ZOO] Type of spicule found in some sponges. { 'am·fē,as·tər }

**Amphibia** [VERT ZOO] A class of vertebrate animals in the superclass Tetrapoda characterized by a moist, glandular skin, gills at some stage of development, and no amnion during the embryonic stage. { am'fib·ē·ə }

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# Exhibit 7

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# Academic Press Dictionary of Science and Technology

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Academic Press, Inc.
1250 Sixth Avenue, San Diego, California 92101-4311

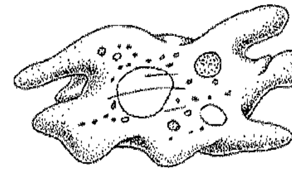
*United Kingdom Edition published by*
Academic Press Limited
24–28 Oval Road, London NW1 7DX

Library of Congress Cataloging-in-Publication Data

Academic Press dictionary of science and technology / edited by
Christopher Morris
p. cm.
ISBN 0-12-200400-0
1. Science--Dictionaries. 2. Technology--Dictionaries.
I. Morris, Christopher G. II. Academic Press. III. Title:
Dictionary of science and technology.
Q123.A33 1991
503--dc20 90-29032
CIP

PRINTED IN THE UNITED STATES OF AMERICA
92 93 94 95 96 97 DO 9 8 7 6 5 4 3 2 1

**amnicolous** [am′nə kā′ ləs] *Ecology.* living or thriving on sandy river banks. Also, **amnicole.**
**amniocentesis** [am′nē ō sen tē′sis] *Medicine.* a procedure for obtaining a sample of amniotic fluid from the uterus of a pregnant woman, usually involving the insertion of a hypodermic needle into the amnion and the withdrawal of amniotic fluid; used to detect fetal disorders and abnormalities or otherwise assess the condition or development of the fetus.
**amniochorial** *Developmental Biology.* pertaining to a combination of amnion and chorion. Also, **amniochorianic.**
**amniocyte** *Cell Biology.* a cell found floating free within the thin membranous sac, or amnion, surrounding an embryo.
**amniogenesis** *Developmental Biology.* the development of the amnion.
**amniography** *Radiology.* an X-ray examination of the amnion after the injection of an opaque solution, to permit viewing of the amniotic cavity and the fetus.
**amnion** [am′nē än] *Vertebrate Zoology.* **1.** in reptiles, birds, and mammals, the thin but tough membrane that forms the inner sac containing a developing embryo and its surrounding fluid (the amniotic fluid). **2.** the entire sac that is formed by this membrane. *Invertebrate Zoology.* a similar membrane found in insects and other invertebrates.
**amnionic** [am′nē än′ik] *Developmental Biology.* relating to or forming an amnion.
**amniorrhea** [am′nē ə rē′ə] *Medicine.* the escape of the amniotic fluid.
**amniorrhexis** *Medicine.* the rupture of the amnion.
**amnioscope** *Medicine.* an endoscope that permits the visual inspection of the fetus and of the color and amount of the amniotic fluid. Thus, **amnioscopy.**
**Amniota** *Vertebrate Zoology.* a collective term for higher land-living vertebrates whose embryos have an amnion, chorion, and allantois; i.e., reptiles, birds, and mammals.
**amniote** *Vertebrate Zoology.* any animal belonging to the Amniota; that is, a land-living vertebrate having an amnion during the embryonic stage.
**amniotic** [am′nē ät′ik] *Developmental Biology.* of or relating to the amnion.
**amniotic cavity** *Developmental Biology.* the area between the embryo and the amniotic membrane, containing the amniotic fluid.
**amniotic fluid** *Developmental Biology.* the watery fluid within the amnion, in which the embryo or fetus is suspended; it serves to cushion the fetus and also acts a medium of chemical exchange.
**amniotic membrane** *Vertebrate Zoology.* see AMNION, def. 1.
**amniotic sac** *Vertebrate Zoology.* see AMNION, def. 2.
**amniotomy** *Medicine.* the deliberate rupture of the fetal membranes to induce labor.
**amobarbital** *Pharmacology.* $C_{11}H_{18}N_2O_3$, a white crystalline powder, slightly soluble in water; a barbiturate used orally as a sedative and hypnotic; it may be addictive if abused.
**A mode** *Acoustics.* a method of ultrasonic medical tomography in which ultrasonic waves are transmitted on a single axial focus for specific applications, such as measurement of corneal thickness or brain development during pregnancy.
**amoeba** [ə mē′bə] *plural,* **amoebas** or **amoebae** [ə mē′bē] see AMEBA and related words.



**Amoeba**

**Amoeba** *Invertebrate Zoology.* the genus of naked protozoans of the rhizopod order Amoebida. Asymmetrical with constantly changing body shape, they move by extruding pseudopodia and usually reproduce by cell fission.
**amoebic** see AMEBIC.
**Amoebida** *Invertebrate Zoology.* an order of naked protozoans belonging to the class Rhizopodea, containing all the amebas that are parasitic in animals.
**Amoebidiaceae** *Mycology.* a single family of fungi belonging to the order Amoebidiales, occurring in ponds and pools and on freshwater arthropods, cladocerans, copepods, amphipods, or mosquito larvae; it obtains its nutrients from water, rather than from its host.
**Amoebidiales** *Mycology.* an order of fungi belonging to the class Trichomycetes, classified as protozoans, that occur in ponds and pools and on freshwater arthropods and insect larvae.
**Amoebobacter** *Bacteriology.* a genus of purple sulfur bacteria of the family Chromatiaceae, consisting of spheroid, nonmotile photosynthetic cells that contain gas vacuoles and fix carbon dioxide in the presence of hydrogen sulfide.
**amoebocyte** see AMEBOCYTE.
**amoeboid** *Geology.* of a fold or other structure, having a shallow dip and no definite shape.
**amoeboid glacier** *Hydrology.* a glacier that is connected with its snowfield for only a part of the year.
**Amoebophryaceae** *Botany.* a monogeneric family of marine dinoflagellates of the order Syndiniales that are intracellular parasites on other marine dinoflagellates and other marine organisms, sometimes even attacking members of their own family.
**Amor** [ə môr′] *Astronomy.* asteroid 1221, discovered in 1932. It measures about half a kilometer in diameter and is located between Mars and Venus. Amor is the prototype of the class of Amor asteroids. (From *Amor* or Cupid, the Roman god of love and son of Mars and Venus.)
**Amor asteroid** *Astronomy.* any of a class of asteroids whose orbit has a perihelion between 1.0 and 1.3 astronomical units, crossing the orbit of Mars but not that of Earth. Also, **Amor object.**
**amorph** [ā′môrf; ă′môrf] *Genetics.* a gene that has no measurable effect; an inactive gene. Thus, **amorphic.**
**amorphic allele** *Genetics.* an allele that is not genetically active.
**amorphism** *Biology.* the fact or condition of being amorphous.
**amorphization** *Biology.* the process of making or becoming amorphous.
**Amorphosporangium** *Bacteriology.* a genus of rod-shaped sporogenous bacteria of the order Actinomycetales, found in leaf litter and other soil habitats; now usually classified as the genus *Actinoplanes.*
**Amorphothecaceae** *Mycology.* a family of fungi belonging to the order Eurotiales, best known for its asexual state, *Hormconis resinae.*
**amorphous** not having a definite form or shape; specific uses include: *Biology.* not having a clearly defined structure or organization, such as amebas or certain bacteria. *Geology.* occurring in a continuous mass, without division into specific parts. *Crystallography.* not having crystals; not crystalline. *Materials Science.* describing a highly viscous liquid that does not possess the crystalline order normally characteristic of the solid state; e.g., glass.
**amorphous frost** *Hydrology.* a frost that lacks crystalline structure.
**amorphous laser** see GLASS LASER.
**amorphous memory array** *Computer Technology.* a physical unit of computer memory composed of a solid noncrystalline material.
**amorphous peat** *Geology.* fine-grained peat in which the original plant structures have been destroyed as a result of the decay of cellulose material.
**amorphous ribbon** *Metallurgy.* a narrow strip of a material that has no crystalline structure.
**amorphous semiconductor** *Solid-State Physics.* a semiconductor material that lacks crystalline (regular) structure, and tends to have lower electrical conductivities than crystalline semiconductors.
**amorphous sky** *Meteorology.* a state of the sky characterized by an abundance of clouds lacking any distinctive form, usually accompanied by precipitation falling from a higher cloud layer.
**amorphous snow** *Hydrology.* snow having an irregular crystalline structure.
**amorphous solid** *Materials Science.* a noncrystalline solid material whose microscopic arrangement exhibits no periodicity or long-range order, and whose shear viscosity is large enough that macroscopic shapes are maintained for relatively long periods.
**amortizement** *Architecture.* the sloping top of a buttress, pillar, or other such projecting feature.
**amosite** *Mineralogy.* a commercial name for iron-rich asbestiform varieties of the amphiboles grunerite, cummingtonite, anthophyllite, and ferro-gedrite. (From an acronym for Asbestos Mine of South Africa + the suffix *-ite.*)
**amount of substance** *Science.* a term for the amount of a given component that is present in a system, solution, medical preparation, or the like.

PACE-037841

# Exhibit 8

# Merriam-Webster's Collegiate® Dictionary

## TENTH EDITION

Merriam-Webster, Incorporated
Springfield, Massachusetts, U.S.A.

PACE-037833

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Library of Congress Cataloging in Publication Data
Main entry under title:

Merriam-Webster's collegiate dictionary. — 10th ed.
p. cm.
Includes index.
ISBN 0-87779-708-0 (unindexed). — ISBN 0-87779-709-9 (indexed).
— ISBN 0-87779-710-2 (deluxe). — ISBN 0-87779-707-2 (laminated cover).
1. English language—Dictionaries. I. Merriam-Webster, Inc.
PE1628.M36 1995
423—dc20 94-30967
CIP

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Made in the United States of America

1112131415RMcN95

PACE-037834

**do·pa·mi·ner·gic** \ˌdō-pə-ˌmē-ˈnər-jik\ *adj* (1970) **:** relating to, participating in, or activated by dopamine or related substances

**dop·ant** \ˈdō-pənt\ *n* [[2]*dope*] (1962) **:** an impurity added usu. in minute amounts to a pure substance to alter its properties

[1]**dope** \ˈdōp\ *n* [D *doop* sauce, fr. *dopen* to dip; akin to OE *dyppan* to dip] (1807) **1 a :** a thick liquid or pasty preparation **b :** a preparation for giving a desired quality to a substance or surface **2 :** absorbent or adsorbent material used in various manufacturing processes (as the making of dynamite) **3 a (1) :** an illicit, habit-forming, or narcotic drug **(2) :** a preparation given to a racehorse to help or hinder its performance **b** *chiefly Southern* **:** a cola drink **c :** a stupid person **4 :** information esp. from a reliable source ⟨the inside ∼⟩

[2]**dope** *vb* **doped; dop·ing** *vt* (1889) **1 :** to treat or affect with dope; *esp* **:** to give a narcotic to **2 :** FIGURE OUT — usu. used with *out* **3 :** to treat with a dopant ∼ *vi* **:** to take dope — **dop·er** *n*

**dope·head** \ˈdōp-ˌhed\ *n* (1903) **:** a drug addict

**dope·ster** \ˈdōp-stər\ *n* (1907) **:** a forecaster of the outcome of future events (as sports contests or elections)

**dop·ey** *also* **dopy** \ˈdō-pē\ *adj* **dop·i·er; -est** (1896) **1 a :** dulled by alcohol or a narcotic **b :** SLUGGISH, STUPEFIED **2 :** STUPID, FATUOUS — **dop·i·ness** *n*

**dop·pel·gäng·er** *or* **dop·pel·gang·er** \ˈdä-pəl-ˌgaŋ-ər, -ˌgeŋ-, ˌdä-pəl-ˈ\ *n* [G *Doppelgänger*, fr. *doppel-* double + *-gänger* goer] (1851) **1 :** a ghostly counterpart of a living person **2 a :** DOUBLE 2a **b :** ALTER EGO b **c :** a person who has the same name as another

**Dopp·ler** \ˈdä-plər\ *adj* (1905) **:** of, relating to, being, or utilizing a shift in frequency in accordance with the Doppler effect; *also* **:** of or relating to Doppler radar

**Doppler effect** *n* [Christian J. *Doppler*] (1905) **:** a change in the frequency with which waves (as sound or light) from a given source reach an observer when the source and the observer are in motion with respect to each other so that the frequency increases or decreases according to the speed at which the distance is decreasing or increasing

**Doppler radar** *n* (1954) **:** a radar system that utilizes the Doppler effect for measuring velocity

**Dor·cas** \ˈdȯr-kəs\ *n* [Gk *Dorkas*] **:** a Christian woman of New Testament times who made clothing for the poor

**Do·ri·an** \ˈdōr-ē-ən, ˈdȯr-\ *n* [L *Dorius* of Doris, fr. Gk *dōrios*, fr. *Dōris*, region of ancient Greece] (1662) **:** a member of an ancient Hellenic race that completed the overthrow of Mycenaean civilization and settled esp. in the Peloponnisos and Crete — **Dorian** *adj*

[1]**Dor·ic** \ˈdȯr-ik, ˈdär-\ *adj* (1569) **1 :** of, relating to, or characteristic of the Dorians **2 :** belonging to the oldest and simplest Greek architectural order — see ORDER illustration **3 :** of, relating to, or constituting Doric

[2]**Doric** *n* (1837) **:** a dialect of ancient Greek spoken esp. in the Peloponnisos, Crete, Sicily, and southern Italy

**dork** \ˈdȯrk\ *n* [perh. alter. of *dick*] (1972) *slang* **:** NERD; *also* **:** JERK 4

**dorky** \ˈdȯr-kē\ *adj* **dork·i·er; -est** (1983) *slang* **:** foolishly stupid **:** INEPT

**dorm** \ˈdȯrm\ *n* (1900) **:** DORMITORY

**dor·man·cy** \ˈdȯr-mən(t)-sē\ *n* (1789) **:** the quality or state of being dormant

**dor·mant** \ˈdȯr-mənt\ *adj* [ME, fixed, stationary, fr. MF, fr. prp. of *dormir* to sleep, fr. L *dormire*; akin to Skt *drāti* he sleeps] (1500) **1 :** represented on a coat of arms in a lying position with the head on the forepaws **2 :** marked by a suspension of activity: as **a :** temporarily devoid of external activity ⟨a ∼ volcano⟩ **b :** temporarily in abeyance yet capable of being activated **3 a :** ASLEEP, INACTIVE **b :** having the faculties suspended **:** SLUGGISH **c :** having biological activity suspended: as **(1) :** being in a state of suspended animation **(2) :** not actively growing but protected (as by bud scales) from the environment — used of plant parts **4 :** associated with, carried out, or applied during a period of dormancy ⟨∼ grafting⟩ ***syn*** see LATENT

**dor·mer** \ˈdȯr-mər\ *n* [MF *dormeor* dormitory, fr. L *dormitorium*] (1592) **:** a window set vertically in a structure projecting through a sloping roof; *also* **:** the roofed structure containing such a window

**dor·mie** *or* **dor·my** \ˈdȯr-mē\ *adj* [origin unknown] (1847) **:** being ahead by as many holes in golf as remain to be played

**dor·mi·to·ry** \ˈdȯr-mə-ˌtōr-ē, -ˌtȯr-\ *n, pl* **-ries** [ME, fr. L *dormitorium*, fr. *dormitus*, pp. of *dormire*] (15c) **1 :** a room for sleeping; *esp* **:** a large room containing numerous beds **2 :** a residence hall providing rooms for individuals or for groups usu. without private baths **3** *chiefly Brit* **:** a residential community inhabited chiefly by commuters

**dor·mouse** \ˈdȯr-ˌmau̇s\ *n, pl* **dor·mice** \-mīs\ [ME *dormowse*, perh. fr. MF *dormir* + ME *mous* mouse] (15c) **:** any of numerous small Old World rodents (families Gliridae and Seleviniidae) that are intermediate in form and behavior between mice and squirrels

**dor·nick** \ˈdȯr-nik, ˈdä-nik\ *n* [prob. fr. Ir *dornóg*] (1840) **:** a stone small enough to throw; *also* **:** a large piece of rock

**do·ron·i·cum** \də-ˈrä-ni-kəm\ *n* [NL, genus name, fr. Ar *darūnaj*, a plant of this genus] (1892) **:** any of a genus (*Doronicum*) of Eurasian perennial composite herbs including several cultivated for their showy yellow flower heads

**dorp** \ˈdȯrp\ *n* [D, fr. MD; akin to OHG *dorf* village — more at THORP] (ca. 1576) **:** VILLAGE

**dors-** *or* **dorsi-** *or* **dorso-** *comb form* [LL *dors-*, fr. L *dorsum*] **1 :** back ⟨*dors*ad⟩ **2 :** dorsal and ⟨*dorso*lateral⟩

**dor·sad** \ˈdȯr-ˌsad\ *adv* (ca. 1803) **:** toward the back **:** DORSALLY

[1]**dorsal** *var of* DOSSAL

[2]**dor·sal** \ˈdȯr-səl\ *adj* [LL *dorsalis*, fr. L *dorsum* back] (1727) **1 :** relating to or situated near or on the back esp. of an animal or of one of its parts **2 :** ABAXIAL — **dor·sal·ly** \-sə-lē\ *adv*

[3]**dorsal** *n* (1834) **:** a dorsally located part; *esp* **:** a thoracic vertebra

**dorsal lip** *n* (1940) **:** the margin of the fold of blastula wall that delineates the dorsal limit of the blastopore, constitutes the primary organizer, and forms the point of origin of chordamesoderm

**dorsal root** *n* (ca. 1934) **:** the one of the two roots of a spinal nerve that passes dorsally to the spinal cord and consists of sensory fibers

**Dor·set** \ˈdȯr-sət\ *n* (1891) **:** any of a breed of domestic white-faced sheep orig. developed in Dorset, England

**dor·si·ven·tral** \ˌdȯr-si-ˈven-trəl\ *adj* (ca. 1882) **1 :** having distinct dorsal and ventral surfaces **2 :** DORSOVENTRAL 1 — **dor·si·ven·tral·i·ty** \-ven-ˈtra-lə-tē\ *n* — **dor·si·ven·tral·ly** \-ˈven-trə-lē\ *adv*

**dor·so·lat·er·al** \ˌdȯr-sō-ˈla-tə-rəl, -ˈla-trəl\ *adj* (1835) **:** of, relating to, or involving both the back and the sides

**dor·so·ven·tral** \-ˈven-trəl\ *adj* [ISV] (1870) **1 :** relating to, involving, or extending along the axis joining the dorsal and ventral sides **2 :** DORSIVENTRAL 1 — **dor·so·ven·tral·i·ty** \-ven-ˈtra-lə-tē\ *n* — **dor·so·ven·tral·ly** \-trə-lē\ *adv*

**dor·sum** \ˈdȯr-səm\ *n, pl* **dor·sa** \-sə\ [L] (1840) **1 :** the upper surface of an appendage or part **2 :** BACK; *esp* **:** the entire dorsal surface of an animal

**do·ry** \ˈdōr-ē, ˈdȯr-\ *n, pl* **dories** [Miskito *dóri* dugout] (1709) **:** a flat-bottomed boat with high flaring sides, sharp bow, and deep V-shaped transom

**dos** *or* **do's** *pl of* [2]DO

**dos·age** \ˈdō-sij\ *n* (ca. 1867) **1 a :** the addition of an ingredient or the application of an agent in a measured dose **b :** the presence and relative representation or strength of a factor or agent **2 a :** DOSE 2 **b (1) :** the giving of a dose **(2) :** regulation or determination of doses **3 :** an exposure to some experience in or as if in measured portions

[1]**dose** \ˈdōs\ *n* [ME, fr. MF, fr. LL *dosis*, fr. Gk, lit., act of giving, fr. *didonai* to give — more at DATE] (15c) **1 a :** the measured quantity of a therapeutic agent to be taken at one time **b :** the quantity of radiation administered or absorbed **2 :** a portion of a substance added during a process **3 :** something experienced as if in a prescribed or measured amount ⟨a daily ∼ of hard work⟩ **4 :** a gonorrheal infection

[2]**dose** *vt* **dosed; dos·ing** (1654) **1 :** to give a dose to; *esp* **:** to give medicine to **2 :** to divide (as a medicine) into doses **3 :** to treat with an application or agent

**do–si–do** \ˌdō-(ˌ)sē-ˈdō\ *n, pl* **do–si–dos** [F *dos-à-dos* back to back] (1926) **:** a square-dance figure: **a :** a figure in which the dancers pass each other right shoulder to right shoulder and circle each other back to back **b :** a figure in which the woman moves in a figure circling first her partner and then the man on her right

**do·sim·e·ter** \dō-ˈsi-mə-tər\ *n* [LL *dosis* + ISV *-meter*] (1938) **:** a device for measuring doses of radiations (as X rays) — **do·si·met·ric** \ˌdō-sə-ˈme-trik\ *adj* — **do·sim·e·try** \dō-ˈsi-mə-trē\ *n*

[1]**doss** \ˈdȯs, ˈdäs\ *vi* [origin unknown] (ca. 1785) *chiefly Brit* **:** to sleep or bed down in a convenient place — usu. used with *down*

[2]**doss** *n* (ca. 1789) *chiefly Brit* **:** a crude or makeshift bed

**dos·sal** \ˈdä-səl\ *or* **dor·sal** \ˈdȯr-səl\ *or* **dos·sel** \ˈdä-səl\ *n* [ML *dossale, dorsale*, fr. neut. of LL *dorsalis* dorsal] (1851) **:** an ornamental cloth hung behind and above an altar

**doss–house** \ˈdȯs-ˌhau̇s, ˈdäs-\ *n* (1888) *chiefly Brit* **:** a cheap rooming house or hotel

**dos·sier** \ˈdȯs-ˌyā, ˈdäs-; ˈdō-sē-ˌā, ˈdä-\ *n* [F, bundle of documents labeled on the back, dossier, fr. *dos* back, fr. L *dorsum*] (1880) **:** a file containing detailed records on a particular person or subject

**dost** \ˈdəst\ *archaic pres 2d sing of* DO

[1]**dot** \ˈdät\ *n* [(assumed) ME, fr. OE *dott* head of a boil; akin to OHG *tutta* nipple] (1674) **1 :** a small spot **:** SPECK **2 a (1) :** a small point made with a pointed instrument ⟨a ∼ on the chart marked the ship's position⟩ **(2) :** a small round mark used in orthography or punctuation ⟨put a ∼ over the *i*⟩ **b :** a centered point used as a multiplication sign (as in 6 • 5 = 30) **c (1) :** a point after a note or rest in music indicating augmentation of the time value by one half **(2) :** a point over or under a note indicating that it is to be played staccato **3 :** a precise point esp. in time ⟨arrived at six on the ∼⟩ **4 :** a short click or buzz forming a letter or part of a letter (as in the Morse code)

[2]**dot** *vb* **dot·ted; dot·ting** *vt* (ca. 1740) **1 :** to mark with a dot **2 :** to intersperse with dots or objects scattered at random ⟨boats *dotting* the lake⟩ ∼ *vi* **:** to make a dot — **dot·ter** *n*

[3]**dot** \ˈdät\ *n* [F, fr. L *dot-, dos* dowry] (1855) **:** DOWRY 2

**dot·age** \ˈdō-tij\ *n* [*dote*] (14c) **:** a state or period of senile decay marked by decline of mental poise and alertness

**do·tal** \ˈdō-tᵊl\ *adj* [L *dotalis*, fr. *dot-, dos*] (1513) **:** of or relating to a woman's marriage dowry

**dot·ard** \ˈdō-tərd\ *n* (14c) **:** a person in his or her dotage

**dote** \ˈdōt\ *vi* **dot·ed; dot·ing** [ME; akin to MLG *dotten* to be foolish] (13c) **1 :** to exhibit mental decline of or like that of old age **:** be in one's dotage **2 :** to be lavish or excessive in one's attention, fondness, or affection — used esp. with *on* ⟨*doted* on her only grandchild⟩ — **dot·er** *n* — **dot·ing·ly** \ˈdō-tiŋ-lē\ *adv*

**doth** \ˈdəth\ *archaic pres 3d sing of* DO

**dot matrix** *n* (1963) **:** a pattern of dots in a grid from which alphanumeric characters can be formed ⟨a *dot matrix* printer⟩

**dot product** *n* [[1]*dot*; fr. its being commonly written *A* • *B*] (1901) **:** SCALAR PRODUCT

**dotted swiss** *n* (ca. 1924) **:** a sheer light muslin ornamented with evenly spaced raised dots

**dot·ter·el** \ˈdä-tə-rəl, ˈdä-trəl\ *n* [ME *dotrelle*, irreg. fr. *doten* to dote] (15c) **:** a Eurasian plover (*Eudromias morinellus*) formerly common in England; *also* **:** any of various related plovers chiefly of eastern Asia, Australia, and So. America

**dot·tle** \ˈdä-tᵊl, ˈdȯ-\ *n* [ME *dottel* plug, fr. (assumed) ME *dot*] (ca. 1825) **:** unburned and partially burned tobacco in the bowl of a pipe

[1]**dot·ty** \ˈdä-tē\ *adj* **dot·ti·er; -est** [alter. of Sc *dottle* fool, fr. ME *dotel*, fr. *doten*] (15c) **1 a :** mentally unbalanced **:** CRAZY **b :** amiably eccentric **2 :** being obsessed or infatuated **3 :** amusingly absurd **:** RIDICULOUS ⟨some sublimely ∼ exchanges of letters⟩ — **dot·ti·ly** \ˈdä-tᵊl-ē\ *adv* — **dot·ti·ness** \ˈdä-tē-nəs\ *n*

[2]**dotty** *adj* (1812) **:** composed of or marked by dots

**Dou·ay Version** \dü-ˈā-\ *n* [*Douay*, France] (1837) **:** an English translation of the Vulgate used by Roman Catholics

[1]**dou·ble** \ˈdə-bəl\ *adj* [ME, fr. OF, fr. L *duplus* (akin to Gk *diploos*), fr. *duo* two + *-plus* multiplied by; akin to OE *-feald* -fold — more at TWO, -FOLD] (13c) **1 :** having a twofold relation or character **:** DUAL **2 :** consisting of two usu. combined members or parts ⟨an egg with a ∼ yolk⟩ **3 a :** being twice as great or as many ⟨∼ the number of expected applicants⟩ **b** *of a coin* **:** worth two of the specified amount ⟨a ∼ eagle⟩ ⟨a ∼ crown⟩ **4 :** marked by duplicity **:** DECEITFUL **5 :** folded in two **6 :** of extra size, strength, or value ⟨a ∼ martini⟩ **7 :** having more than the normal number of floral leaves often at the expense of the sporophylls **8** *of rhyme* **:** involving correspondence of two syllables (as in *exciting* and *inviting*) **9 :** designed for the use of two persons ⟨a ∼ room⟩ ⟨a ∼ bed⟩ — **dou·ble·ness** *n*

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# MODERN DICTIONARY *of* ELECTRONICS

RUDOLF F. GRAF

Newnes

PACE-037851

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**Library of Congress Cataloging-in-Publication Data**

Graf, Rudolf F.
Modern dictionary of electronics / Rudolf F. Graf.—7th ed., revised and updated.
p. cm.
ISBN 0-7506-9866-7 (alk. paper)
1. Electronics—Dictionaries. I. Title
TK7804.G67 1999
621.381'03—dc21 99-17889
CIP

**British Library Cataloguing-in-Publication Data**
A catalogue record for this book is available from the British Library.

The publisher offers special discounts on bulk orders of this book.
For information, please contact:
Manager of Special Sales
Butterworth-Heinemann
225 Wildwood Avenue
Woburn, MA 01801-2041
Tel: 781-904-2500
Fax: 781-904-2620

For information on all Butterworth-Heinemann publications available, contact our World Wide Web home page at: http://www.bh.com

10 9 8 7 6 5 4 3 2 1

Typeset by Laser Words, Madras, India
Printed in the United States of America

PACE-037852

coatings, this corresponds to one oxide particle. 2. A region within a ferromagnetic substance where the atomic magnets of many atoms tend to orient themselves parallel to each other; the north poles pointing one way act spontaneously. The domains may be treated as small bar magnets of microscopic dimension. 3. In the Internet and other networks, an extension in a host name that identifies the type of host. The seven domains established by the InterNIC are .arpa (ARPANET), .com (company/commercial), .edu (educational institutions), .gov (government), .mil (military), .net (Internet access providers), and .org (organization). Outside the United States, the domain name is a two-letter country code (for example, .fr for France and .ca for Canada).

**domain name** — The unique name that identifies an Internet site. Domain names always have two or more parts, separated by dots. The part on the left is the most specific, and the part on the right is the most general. A given machine may have more than one domain name, but a given domain name points to only one machine. Usually, all of the machines on a given network will have the same thing as the right-hand portion of their domain names.

**domains** — *See* particles.

**domestic induction heater** — A home cooking utensil that is heated by induced currents within it. The unit contains a primary inductor, with the utensil itself acting as the secondary.

**dominant mode** — Also called fundamental mode or principal mode. In waveguide transmission, the mode with the lowest cutoff frequency. Designations for this mode are $TE_{0,1}$ and $TE_{1,1}$ for rectangular and circular waveguides, respectively.

**dominant wave** — The guided wave that has the lowest cutoff frequency. It is the only wave that will carry energy when the excitation frequency is between the lowest and the next higher cutoff.

**dominant wavelength** — 1. Of a color sample, the wavelength of light that matches it in chromaticity when mixed with white light. 2. The wavelength that is a quantitative measure of the apparent color of light as perceived by the human eye.

**dominant wavelength of a color** — The predominant wavelength of light in a color.

**donor** — Also called donor impurity. 1. An impurity atom that tends to give up an electron and thereby affects the electrical conductivity of a crystal. Used to produce n-type semiconductors. 2. A chemical that adds electrons to crystal lattices. 3. An impurity from column V of the periodic table, which adds a mobile electron to the conduction band of silicon, thereby making it more n-type. Commonly used donors are arsenic and phosphorous (compare with *acceptor*).

**donor impurity** — An element or compound whose atoms or molecules have more valence electrons than those of the intrinsic semiconductor material into which they are introduced in small quantities as an impurity or dopant. Because the donor impurity possesses more valence electrons, the material doped with a donor impurity is an n-type semiconductor. *See* donor.

**donor-type semiconductor** — An n-type semiconductor.

**donut** — *See* land, 2.

**door cord** — A short, insulated cable with an attaching block and terminals at each end used to conduct current to a device, such as foil, mounted on the movable portion of a door or window.

**doorknob tube** — A vacuum tube so called because of its shape designed for UHF transmitter circuits. It has a low electron-transit time and low interelectrode capacitance because of the close spacing and small size, respectively, of its electrodes.

**door trip switch** — A mechanical switch mounted so that movement of a door will operate the switch.

**dopant** — 1. An impurity added to a semiconductor to improve its electrical conductivity; any material added to a substance to produce desired properties in the substance. 2. Selected impurity introduced into semiconductor substrates in controlled amounts, the atoms of which form negative (n-type) and positive (p-type) conductive regions. Phosphorus, arsenic, and antimony are n-type dopants for silicon; boron, aluminum, gallium, and indium are p-type dopants for silicon.

**dope** — To add impurities (called dopants) to a substance, usually a solid, in a controlled manner to cause the substance to have certain desired properties. For example, the number of electrical carriers in silicon can be increased by doping it with small amounts of other semimetallic elements. Ruby is aluminum oxide doped with chromium oxide.

**doped junction** — A semiconductor junction produced by the addition of an impurity to the melt during crystal growth.

**doped region** — A layer of an integrated circuit in which impurities have been introduced.

**doped solder** — Solder to which an element not normally found in solder has been intentionally added.

**doping** — The addition of controlled amounts of impurities to a semiconductor to achieve a desired characteristic, such as to produce an n-type or p-type material accomplished through thermal diffusion or ion implantation. Common doping agents for germanium and silicon include aluminum, antimony, arsenic, gallium, and indium.

**doping agent** — An impurity element added to semiconductor materials used in crystal diodes and transistors. Common doping agents for germanium and silicon include aluminum, antimony, arsenic, gallium, and indium.

**doping compensation** — The addition of donor impurities to a p-type semiconductor or of acceptor impurities to an n-type semiconductor.

**Doppler cabinet** — A speaker cabinet in which either the speaker or a baffle board is rotated or moved to change the length of the sound path cyclically and thereby produce a vibrato effect mechanically.

**Doppler effect** — 1. The observed change of frequency of a wave caused by a time rate of change of the effective distance traveled by the wave between the source and the point of observation. As the distance between a source of constant vibration and an observer diminishes or increases, the received frequencies are greater or less. 2. The apparent change in the frequency of radio wave reaching an observer, due either to motion of the source toward or away from the observer, to motion of the observer, or both. 3. The apparent change in frequency of sound or radio waves when reflected from or originating from a moving object. Utilized in some types of motion sensors. 4. The radiation emitted from a source that moves away from an observer appears to be of lower frequency than the radiation emitted from a stationary source. The radiation emitted from a source moving toward the observer appears to be of a higher frequency than that from a stationary source.

**Doppler principle** — The theory established by Doppler in 1842 that states that the rate of change in distance between a perceiver and a radiation source determines the change in frequencies.

**Doppler radar** — A radar unit that measures the velocity of a moving object by the shift in carrier

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ISBN 0-87779-911-3
9 780877 799115 50599

# The Merriam-Webster Dictionary

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Springfield, Massachusetts, U.S.A.

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ISBN 0-87779-911-3

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2930QP/B0099

# Preface

This new edition of THE MERRIAM-WEBSTER DICTIONARY is the fifth in a line of Merriam-Webster paperback dictionaries which began in 1947. It is based on and preserves the best aspects of preceding editions, but it also offers much that is new, drawing specifically on *Merriam-Webster's Collegiate Dictionary, Tenth Edition*, which was published after the appearance of the last paperback edition. Every entry and every section has been reexamined and revised in light of the most current information available. Every definition has been based on examples of actual use found in the Merriam-Webster citation file, which now includes more than 14,500,000 examples of English words used in context.

The 60,000 entries in *The Merriam-Webster Dictionary* give coverage to the most frequently used words in the language. The heart of the dictionary is the A-Z vocabulary section, where readers will find information about meaning, spelling, pronunciation, etymology, and synonymy. This section is followed by several others that users have long found useful: a list of foreign words and phrases that often occur in English texts; a list of nations of the world; a list of places in the United States having 18,000 or more inhabitants; a similar list of places in Canada; and a section devoted to widely used signs and symbols. The A-Z vocabulary is preceded by a set of Explanatory Notes that should be read carefully by every user of the dictionary. An understanding of the information contained in these notes will make the dictionary both easier and more rewarding to use.

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PACE-037855

if a competitor wins, places, or shows ⟨an ~ bet⟩ 2 : including all classes or categories ⟨an ~ wage increase⟩

**acros·tic** \ə-ˈkrȯs-tik\ *n* : a composition usu. in verse in which the initial or final letters of the lines taken in order form a word or phrase — **acrostic** *adj*

**acryl·ic** \ə-ˈkri-lik\ *n* 1 : ACRYLIC RESIN 2 : a paint in which the vehicle is acrylic resin 3 : a quick-drying synthetic textile fiber

**acrylic resin** *n* : a glassy thermoplastic used for cast and molded parts or as coatings and adhesives

[1]**act** \ˈakt\ *n* 1 : a thing done : DEED 2 : STATUTE, DECREE 3 : a main division of a play; *also* : an item on a variety program 4 : an instance of insincere behavior : PRETENSE

[2]**act** *vb* 1 : to perform by action esp. on the stage; *also* : FEIGN, SIMULATE, PRETEND 2 : to take action 3 : to conduct oneself : BEHAVE 4 : to perform a specified function 5 : to produce an effect

[3]**act** *abbr* 1 active 2 actual

**ACT** *abbr* Australian Capital Territory

**actg** *abbr* acting

**ACTH** \ˌā-(ˌ)sē-(ˌ)tē-ˈāch\ *n* : a protein hormone of the pituitary gland that stimulates the adrenal cortex

**act·ing** \ˈak-tiŋ\ *adj* : doing duty temporarily or for another ⟨~ president⟩

**ac·tin·i·um** \ak-ˈti-nē-əm\ *n* : a radioactive metallic chemical element

**ac·tion** \ˈak-shən\ *n* 1 : a legal proceeding 2 : the manner or method of performing 3 : ACTIVITY 4 : ACT, DEED 5 : the accomplishment of a thing usu. over a period of time, in stages, or with the possibility of repetition 6 *pl* : CONDUCT 7 : COMBAT, BATTLE 8 : the events of a literary plot 9 : an operating mechanism ⟨the ~ of a gun⟩; *also* : the way it operates ⟨stiff ~⟩

**ac·tion·able** \ˈak-sh(ə-)nə-bəl\ *adj* : affording ground for an action or suit at law — **ac·tion·ably** \-blē\ *adv*

**ac·ti·vate** \ˈak-tə-ˌvāt\ *vb* **-vat·ed; -vat·ing** 1 : to spur into action; *also* : to make active, reactive, or radioactive 2 : to treat (as carbon) so as to improve adsorptive properties 3 : to set up (a military unit) formally; *also* : to call to active duty — **ac·ti·va·tion** \ˌak-tə-ˈvā-shən\ *n* — **ac·ti·va·tor** \ˈak-tə-ˌvā-tər\ *n*

**ac·tive** \ˈak-tiv\ *adj* 1 : causing or involving action or change 2 : asserting that the grammatical subject performs the action represented by the verb ⟨~ voice⟩ 3 : BRISK, LIVELY 4 : erupting or likely to erupt ⟨~ volcano⟩ 5 : presently in operation or use 6 : tending to progress or to cause degeneration ⟨~ tuberculosis⟩ — **active** *n* — **ac·tive·ly** *adv* — **ac·tive·ness** *n*

**ac·tiv·ism** \ˈak-ti-ˌvi-zəm\ *n* : a doctrine or practice that emphasizes vigorous action for political ends — **ac·tiv·ist** \-vist\ *n or adj*

**ac·tiv·i·ty** \ak-ˈti-və-tē\ *n, pl* **-ties** 1 : the quality or state of being active 2 : forceful or energetic action 3 : an occupation in which one is engaged

**ac·tor** \ˈak-tər\ *n* : a person who acts in a play or motion picture

**ac·tress** \ˈak-trəs\ *n* : a woman who is an actor

**Acts** \ˈakts\ *or* **Acts of the Apostles** *n* — see BIBLE table

**ac·tu·al** \ˈak-chə-wəl, -shə-\ *adj* : really existing : REAL — **ac·tu·al·i·ty** \ˌak-chə-ˈwa-lə-tē, -shə-\ *n* — **ac·tu·al·iza·tion** \ˌak-chə-wə-lə-ˈzā-shən, -shə-\ *n* — **ac·tu·al·ize** \ˈak-chə-wə-ˌlīz, -shə-\ *vb*

**ac·tu·al·ly** \ˈak-chə-wə-lē, -shə-\ *adv* : in fact or in truth : REALLY

**ac·tu·ary** \ˈak-chə-ˌwer-ē, -shə-\ *n, pl* **-ar·ies** : a person who calculates insurance risks and premiums — **ac·tu·ar·i·al** \ˌak-chə-ˈwer-ē-əl, -shə-\ *adj*

**ac·tu·ate** \ˈak-chə-ˌwāt\ *vb* **-at·ed; -at·ing** 1 : to put into action 2 : to move to action — **ac·tu·a·tion** \ˌak-chə-ˈwā-shən, -shə-\ *n* — **ac·tu·a·tor** \ˈak-chə-ˌwā-tər, -shə-\ *n*

**act up** *vb* 1 : MISBEHAVE 2 : to function improperly

**acu·ity** \ə-ˈkyü-ə-tē\ *n, pl* **-ities** : keenness of perception

**acu·men** \ə-ˈkyü-mən\ *n* : mental keenness and penetration **syn** discernment, insight, percipience, perspicacity

**acu·pres·sure** \ˈa-kyu̇-ˌpre-shər\ *n* : SHIATSU

**acu·punc·ture** \-ˌpəŋk-chər\ *n* : an orig. Chinese practice of puncturing the body (as with needles) at specific points to cure disease or relieve pain — **acu·punc·tur·ist** \ˌa-kyu̇-ˈpəŋk-chə-rist\ *n*

**acute** \ə-ˈkyüt\ *adj* **acut·er; acut·est** [L *acutus*, pp. of *acuere* to sharpen, fr. *acus* needle] 1 : SHARP, POINTED 2 : containing less than 90 degrees ⟨an ~ angle⟩ 3 : sharply perceptive; *esp* : mentally keen 4 : SEVERE ⟨~ distress⟩; *also* : having a sudden onset, sharp rise, and short duration ⟨~ inflammation⟩ 5 : of, marked by, or being an accent mark having the form ´ — **acute·ly** *adv* — **acute·ness** *n*

**acy·clo·vir** \(ˌ)ā-ˈsī-klō-ˌvir\ *n* : a drug used esp. to treat the genital form of herpes simplex

**ad** \ˈad\ *n* : ADVERTISEMENT

**AD** *abbr* 1 after date 2 [L *anno Domini*] in the year of our Lord — often printed in small capitals and often punctuated 3 assistant director 4 athletic director

**ad·age** \ˈa-dij\ *n* : an old familiar saying : PROVERB, MAXIM

[1]**ada·gio** \ə-ˈdä-j(ē-ˌ)ō, -zh(ē-ˌ)ō\ *adv or adj* [It] : at a slow tempo — used as a direction in music

[2]**adagio** *n, pl* **-gios** 1 : an adagio movement 2 : a ballet duet or trio displaying feats of lifting and balancing



[1]**ad·a·mant** \ˈa-də-mənt, -ˌmant\ *n* [ME, fr. OF, fr. L *adamant-, adamas* hardest metal, diamond, fr. Gk] : a stone believed to be impenetrably hard — **ad·a·man·tine** \ˌa-də-ˈman-ˌtēn, -ˌtīn\ *adj*

[2]**adamant** *adj* : INFLEXIBLE, UNYIELDING — **ad·a·mant·ly** *adv*

**Ad·am's apple** \ˈa-dəmz-\ *n* : the projection in front of the neck formed by the largest cartilage of the larynx

**adapt** \ə-ˈdapt\ *vb* : to make suitable or fit (as for a new use or for different conditions) **syn** adjust, accommodate, conform — **adapt·abil·i·ty** \ə-ˌdap-tə-ˈbi-lə-tē\ *n* — **adapt·able** *adj* — **ad·ap·ta·tion** \ˌa-ˌdap-ˈtā-shən\ *n* — **ad·ap·ta·tion·al** \-sh(ə-)nəl\ *adj* — **adap·tive** \ə-ˈdap-tiv\ *adj* — **ad·ap·tiv·i·ty** \ˌa-ˌdap-ˈti-və-tē\ *n*

**adapt·er** *also* **adap·tor** \ə-ˈdap-tər\ *n* 1 : one that adapts 2 : a device for connecting two dissimilar parts of an apparatus 3 : an attachment for adapting apparatus for uses not orig. intended

**ADC** *abbr* 1 aide-de-camp 2 Aid to Dependent Children

**add** \ˈad\ *vb* 1 : to join to something else so as to increase in number or amount 2 : to say further ⟨let me ~ this⟩ 3 : to combine (numbers) into one sum

**ad·dend** \ˈa-ˌdend\ *n* : a number to be added to another

**ad·den·dum** \ə-ˈden-dəm\ *n, pl* **-da** \-də\ [L] : something added; *esp* : a supplement to a book

[1]**ad·der** \ˈa-dər\ *n* 1 : a poisonous European viper or a related snake 2 : any of various harmless No. American snakes (as the hognose snake)

[2]**add·er** \ˈa-dər\ *n* : one that adds; *esp* : a device that performs addition

[1]**ad·dict** \ə-ˈdikt\ *vb* 1 : to devote or surrender (oneself) to something habitually or excessively 2 : to cause addiction to a substance in (as a person) — **ad·dic·tive** \-ˈdik-tiv\ *adj*

[2]**ad·dict** \ˈa-(ˌ)dikt\ *n* : one who is addicted to a substance

**ad·dic·tion** \ə-ˈdik-shən\ *n* 1 : the quality or state of being addicted 2 : compulsive need for and use of a habit-forming substance (as heroin, nicotine, or alcohol) characterized by well-defined physiological symptoms upon withdrawal; *also* : persistent compulsive use of a substance known by the user to be harmful

**ad·di·tion** \ə-ˈdi-shən\ *n* 1 : the act or process of adding; *also* : something added 2 : the operation of combining numbers to obtain their sum **syn** accretion, increment, accession, augmentation

**ad·di·tion·al** \ə-ˈdi-sh(ə-)nəl\ *adj* : coming by way of addition : ADDED, EXTRA

**ad·di·tion·al·ly** \ə-ˈdi-sh(ə-)nə-lē\ *adv* : in or by way of addition : FURTHERMORE

[1]**ad·di·tive** \ˈa-də-tiv\ *adj* 1 : of, relating to, or characterized by addition 2 : produced by addition — **ad·di·tiv·i·ty** \ˌa-də-ˈti-və-tē\ *n*

[2]**additive** *n* : a substance added to another in small quantities to effect a desired change in properties ⟨food ~s⟩

**ad·dle** \ˈad-ᵊl\ *vb* **ad·dled; ad·dling** 1 : to throw into confusion : MUDDLE 2 : to become rotten ⟨*addled* eggs⟩

**addn** *abbr* addition

**addnl** *abbr* additional

**add–on** \ˈad-ˌȯn, -ˌän\ *n* : something (as a feature or accessory) added esp. as an enhancement

[1]**ad·dress** \ə-ˈdres\ *vb* 1 : to direct the attention of (oneself) 2 : to direct one's remarks to : deliver an address to 3 : to mark directions for delivery on 4 : to identify (as a memory location) by an address

[2]**ad·dress** \ə-ˈdres, ˈa-ˌdres\ *n* 1 : skillful management 2 : a formal speech : LECTURE 3 : the place where a person or organization may be communicated with 4 : the directions for delivery placed on mail 5 : a location (as in a computer's memory) where particular data is stored

**ad·dress·ee** \ˌa-ˌdre-ˈsē, ə-ˌdre-ˈsē\ *n* : one to whom something is addressed

**ad·duce** \ə-ˈdüs, -ˈdyüs\ *vb* **ad·duced; ad·duc·ing** : to offer as argument, reason, or proof **syn** advance, allege, cite, submit — **ad·duc·er** *n*

**-ade** *n suffix* 1 : act : action ⟨block*ade*⟩ 2 : product; *esp* : sweet drink ⟨lime*ade*⟩

**ad·e·nine** \ˈad-ᵊn-ˌēn\ *n* : one of the purine bases that make up the genetic code of DNA and RNA

**ad·e·noid** \ˈad-ˌnȯid, -ᵊn-ˌȯid\ *n* : an enlarged mass of tissue near the opening of the nose into the throat — usu. used in pl. — **adenoid** *or* **ad·e·noi·dal** \ˌad-ˈnȯi-dəl, -ᵊn-ˈȯi-\ *adj*

**aden·o·sine tri·phos·phate** \ə-ˈde-nə-ˌsēn-trī-ˈfäs-ˌfāt\ *n* : ATP

[1]**ad·ept** \ˈa-ˌdept\ *n* : EXPERT

[2]**adept** \ə-ˈdept\ *adj* : highly skilled : EXPERT — **adept·ly** *adv* — **adept·ness** *n*

**ad·e·quate** \ˈa-di-kwət\ *adj* : equal to or sufficient for a specific requirement — **ad·e·qua·cy** \-kwə-sē\ *n* — **ad·e·quate·ly** *adv* — **ad·e·quate·ness** *n*

**ad·here** \ad-ˈhir\ *vb* **ad·hered; ad·her·ing** 1 : to give support : maintain loyalty 2 : to stick fast : CLING — **ad·her·ence** \-ˈhir-əns\ *n* — **ad·her·ent** \-ənt\ *adj or n*

**ad·he·sion** \ad-ˈhē-zhən\ *n* 1 : the act or state of adhering 2 : the union of bodily tissues abnormally grown together after inflammation; *also* : the newly formed uniting tissue 3 : the molecular attraction between the surfaces of bodies in contact

[1]**ad·he·sive** \-ˈhē-siv, -ziv\ *adj* 1 : tending to adhere : STICKY 2 : prepared for adhering

# Exhibit 11

# THE AMERICAN HERITAGE® COLLEGE DICTIONARY

THIRD EDITION

HOUGHTON MIFFLIN COMPANY
*Boston • New York*

PACE-037857

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0-395-67161-2 (UPC)

*Library of Congress Cataloging-in-Publication Data*

The American heritage college dictionary. —3rd ed.
p. cm.
ISBN 0-395-66917-0 (plain edge). —ISBN 0-395-44638-4 (thumb edge). —ISBN 0-395-66918-9 (deluxe binding).
1. English language—Dictionaries. 2. Americanisms.
PE1628.A6227 1993
423—dc20 92-42124
CIP

Manufactured in the United States of America

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kla-) n. A synthetic purine nucleo-
used topically in the treatment of
[A-1 + CYCLO- + VIR(AL) OR VIR(US).]
adical having the general formula
rganic acid. [AC(ID) + -YL.]
nt.
intage in tennis.
Air-dried.

Domini.
ag- or al- or ap- or as- or at-,
, k, l, p, q, s, and t, ad- is usually
, ac-, al-, ap-, ac-, as-, and at-, re-
trenal. [Lat. < ad, to. See ad-*.]
; toward: cephalad. [< Lat. ad, to.

central OK SE of Oklahoma City.

A programming language, based on
the U.S. Department of Defense.
, Countess of Lovelace (1815–52).]
ntal Association. 2. American Dia-
ericans for Democratic Action.
onal saying; a proverb. [Fr. < OFr.

netimes claimed that the expression
inasmuch as a saying must have a
r to count as an adage in the first
ge is first recorded by the Oxford
phrase old adage, showing that this
old. Such idiomatic redundancy is
ses such as young whelp.
-zhō, -zhē-ō) adv. & adj. Mus. In a
os. 1. Mus. A slow passage, move-
on of a pas de deux requiring great
and turning. [Ital. : ad-, at (< Lat.;
OProv. aize < VLat. *adiacēs < Lat.
ADJACENT).]
of W AK in the central Aleutian Is.
ible, the first man and the husband

or relating to the neoclassic style of
e originated by Robert and James

British neoclassic architect and de-
with his brother James (1730–94).
ad-ēv') n. See puttyroot.
mănt') adj. Impervious to pleas or
ding. — n. 1. A stone once believed
hardness. 2. An extremely hard sub-
recious stone < OFr. adamaunt <
ard steel, diamond, anything inflex-
mant-, hard steel, diamond, anything
onquerable. See demə-*.]
'tēn', -tīn', -tĭn) adj. 1. Made of or
Having the hardness or luster of a
inflexible.
Smith. 1744–1818. First Lady of

Amer. photographer noted for his
aphs of the wilderness.
'27. Amer. historian who theorized
l fall according to a pattern of eco-
ic.
807–86. Amer. public official who
Great Britain during the Civil War.
F.P.A." 1881–1960. Amer. humorist
g Tower" column.
38–1918. Amer. historian noted for
Education of Henry Adams (1918).
The first Vice President (1789–97)
97–1801) of the U.S. He was a ma-
ting of the Declaration of Independ-
n.
7–1848. The sixth President of the
r served in the House of Represen-
e he advocated antislavery measures.
,753.6 m (12,307 ft), in the Cascade

1803. Amer. Revolutionary leader
Bostonians toward rebellion against
ule.
c. The slight projection at the front of
e largest cartilage of the larynx.
ma's Bridge (ă'məz). A chain of
d Sri Lanka.
ə-nēd'l) n. Any of several related,
enus Yucca. [From the spines on its

n, 2,244.8 m (7,360 ft), in S-central
site for Buddhists, Hindus, and Mus-



**A·da·na** (ä'də-nə, ə-dä'nə). A city of S Turkey near the Mediterranean; probably founded by the Hittites. Pop. 574,515.

**a·dapt** (ə-dăpt') *v.* **a·dapt·ed, a·dapt·ing, a·dapts.** —*tr.* To make suitable to a specific use or situation. —*intr.* To become adapted. [ME *adapten* < Lat. *adaptāre*: *ad-*, ad- + *aptāre*, to fit (< *aptus*, fitting; see APT).]

**Syns:** *adapt, accommodate, adjust, conform, fit, reconcile.* The central meaning shared by these verbs is "to make suitable to or consistent with a particular situation or use": *adapted themselves to city life; can't accommodate myself to the new requirements; adjusting their behavior to the rules; conforming her life to the church's teachings; fit the punishment to the crime; couldn't reconcile his gentle words with his hostile actions.* **Ant:** *unfit.*

**a·dapt·a·ble** (ə-dăp'tə-bəl) *adj.* Capable of adapting or of being adapted. —**a·dapt'a·bil'i·ty, a·dapt'a·ble·ness** *n.*

**ad·ap·ta·tion** (ăd'ăp-tā'shən) *n.* **1.a.** The act or process of adapting. **b.** The state of being adapted. **2.a.** Something that is changed or changes to become suitable to a new situation. **b.** A composition recast into a new form: *an adaptation of a novel for the stage.* **3.** *Biol.* A usu. hereditary alteration in an organism that facilitates its survival and reproduction. **4.** *Physiol.* The responsive adjustment of a sense organ, such as the eye, to varying conditions, such as light intensity. **5.** Change in behavior in response to new surroundings. —**ad'ap·ta'tion·al** *adj.* —**ad'ap·ta'tion·al·ly** *adv.*

**a·dapt·er** also **a·dap·tor** (ə-dăp'tər) *n.* One that adapts, such as a device used to connect different pieces of apparatus.

**a·dap·tion** (ə-dăp'shən) *n.* Adaptation.

**a·dap·tive** (ə-dăp'tĭv) *adj.* Showing or capable of adaptation. —**a·dap'tive·ly** *adv.* —**a·dap'tive·ness** *n.*

**adaptive radiation** *n.* Diversification of a species or single ancestral type into several forms that are each adaptively specialized to a specific environmental niche.

**A·dar** (ä-där', ä'där) *n.* The sixth month of the year in the Jewish calendar. [Heb. *'ădār* < Akkadian *adaru*, a month of the Akkadian calendar corresponding to parts of February and March.]

**Adar She·ni** (shā-nē') *n.* An extra month of the Hebrew year, having 29 days, added in leap years after the regular month of Adar. [Heb. *'ădār šēnī*, second Adar.]

**ad·ax·i·al** (ăd-ăk'sē-əl) *adj.* Located on the side nearest to the axis of an organ or organism.

**ADC** *abbr.* **1.** Also **a.d.c.** Aide-de-camp. **2.** Aid to Dependent Children. **3.** Air Defense Command.

**add** (ăd) *v.* **add·ed, add·ing, adds.** —*tr.* **1.** To combine into a sum. **2.** To join or unite so as to increase in size, quantity, quality, or scope: *added 12 inches to the deck.* **3.** To say or write further. —*intr.* **1.** To find a sum in arithmetic. **2.** To constitute an addition: *an exploit that will add to her reputation.* **3.** To make or create an addition. —***phrasal verb.* add up. 1.** To be reasonable, plausible, or consistent; make sense. **2.** To amount to an expected total. —***idiom.* add up to.** To constitute; amount to: *This movie adds up to a lot of tears.* [ME *adden* < Lat. *addere*: *ad-*, ad- + *dare*, to give; see **dō-*.**] —**add'a·ble, add'i·ble** *adj.*

**ADD** *abbr.* Attention deficit disorder.

**add.** *abbr.* **1.** Addendum. **2.** Addition.

**Ad·dams** (ăd'əmz), **Jane.** 1860–1935. Amer. social reformer who shared the 1931 Nobel Peace Prize.

**ad·dax** (ăd'ăks') *n.* An antelope *(Addax nasomaculatus)* of northern Africa having long twisted horns. [Lat., of African orig.]

**ad·dend** (ăd'ĕnd', ə-dĕnd') *n.* Any of a set of numbers to be added. [Short for ADDENDUM.]

**ad·den·dum** (ə-dĕn'dəm) *n., pl.* **-da** (-də). Something added or to be added, esp. a supplement to a book. [Lat., neut. gerundive of *addendus*, gerundive of *addere*, to add. See ADD.]

**add·er¹** (ăd'ər) *n.* One that adds, esp. a computational device that performs arithmetic addition.

**ad·der²** (ăd'ər) *n.* **1.** See **viper** 1. **2.** Any of several nonvenomous snakes popularly believed to be harmful. [ME < *an addre*, alteration of *a naddre*: *a*, a; see A² + *naddre*, snake (< OE *nǣdre*).]

***Word History:*** The biblical injunction to be wise as serpents and innocent as doves looks somewhat alien in Middle English "Loke ye be prudent as neddris and symple as dowves." *Neddris* would be *adders* in Modern English, with a different meaning and form. *Adder*, an example of specialization in meaning, no longer refers to just any serpent or snake, as it once did, but now denotes only specific kinds of snakes. *Adder* also illustrates a process known as false splitting, or juncture loss: the word came from Old English *nǣdre* and kept its *n* into the Middle English period, but later during that stage of the language people started writing the phrase *a naddre* as *an addre*, which has given us *adder*.

**ad·der's-mouth** (ăd'ərz-mouth') *n.* Any of various chiefly terrestrial orchids of the genus *Malaxis*, having small, often greenish flowers. [From the resemblance of its flowers to the open mouths of snakes.]

**ad·der's-tongue** (ăd'ərz-tŭng') *n.* **1.** See **adder's-tongue fern.** **2.** See **dogtooth violet.**

**adder's-tongue fern** *n.* Any of various ferns in the genus *Ophioglossum*, having leaves divided into a simple sterile blade and a slender, spikelike spore-bearing segment. [From the resemblance of the spike at the base of the frond to a snake's tongue.]

**ad·dict** (ə-dĭkt') *tr.v.* **-dict·ed, -dict·ing, -dicts. 1.** To devote or give (oneself) habitually or compulsively. **2.** To cause to become compulsively and physiologically dependent on a habit-forming substance. —*n.* (ăd'ĭkt). **1.** One who is addicted, as to narcotics. **2.** A devoted believer or follower. [Lat. *addīcere*, *addict-*, to sentence : *ad-*, ad- + *dīcere*, to adjudge; see **deik-*.**] —**ad·dic'tive** *adj.*

**ad·dic·tion** (ə-dĭk'shən) *n.* The quality or condition of being addicted, esp. to a habit-forming substance.

**Ad·dis Ab·a·ba** (ăd'ĭs ăb'ə-bə, ä'dĭs ä'bə-bä'). The cap. of Ethiopia, in the center on a high plateau; held by the Italians from 1936 to 1941. Pop. 1,408,068.

**Ad·di·son** (ăd'ĭ-sən). A village of NE IL, a suburb of Chicago. Pop. 32,058.

**Addison, Joseph.** 1672–1719. English essayist whose works appeared in *The Tatler* and *The Spectator*. —**Ad'di·so'ni·an** (-sō'nē-ən) *adj.*

**Ad·di·son's disease** (ăd'ĭ-sənz) *n.* A disease caused by failure of adrenocortical function and characterized by bronze pigmentation of the skin, anemia, weakness, and low blood pressure. [After Thomas *Addison* (1793–1860), British physician.]

**ad·di·tion** (ə-dĭsh'ən) *n.* **1.** The act or process of adding, esp. of combining numbers into a sum. **2.** Something added, such as a room to a building. —***idioms.* in addition.** Also; as well as. **in addition to.** Over and above; besides. [ME < OFr. < Lat. *additiō*, *additiōn-* < *additus*, p.part. of *addere*, to add. See ADD.] —**ad·di'tion·al** *adj.* —**ad·di'tion·al·ly** *adv.*

**ad·di·tive** (ăd'ĭ-tĭv) *n.* A substance added in small amounts to something else to improve, strengthen, or otherwise alter it. —*adj.* Marked by or involving addition.

**additive identity** *n. Math.* An identity element that in a given mathematical system leaves unchanged any element to which it is added.

**additive inverse** *n. Math.* See **inverse** 2b.

**ad·dle** (ăd'l) *v.* **-dled, -dling, -dles.** —*tr.* To muddle; confuse: *The heat addled his brain.* See Syns at **confuse.** —*intr.* **1.** To become confused. **2.** To become rotten; spoil. [< ME *adel*, rotten < OE *adel*, pool of excrement.]

**ad·dle·pat·ed** (ăd'l-pā'tĭd) *adj.* Muddled; confused.

**add-on** (ăd'ŏn', -ôn') *n.* One thing added to another, esp. a component that enhances a device.

**ad·dress** (ə-drĕs') *tr.v.* **-dressed, -dress·ing, -dress·es. 1.** To speak to, esp. when using a formal name. **2.** To make a formal speech to. **3.** To direct (a spoken or written comment) to someone's attention: *Address your remarks to the manager.* **4.** To mark with a destination: *address a letter.* **5.a.** To direct the efforts of (oneself): *address oneself to a task.* **b.** To deal with; manage. **6.** *Sports.* To adjust the club behind (a golf ball) before a stroke. —*n.* **1.** A formal communication: *used the proper address for a priest.* **2.** A formal speech. **3.** (*also* ăd'rĕs'). The written directions on mail indicating destination. **4.** (*also* ăd'rĕs'). The location at which a person or organization may be found or reached. **5.** Courteous attention. Often used in the plural. **6.** The manner or bearing of a person, esp. in conversation. **7.** Skill and grace in dealing with people or situations. **8.** *Comp. Sci.* A number that designates a specific memory location. [ME *adressen*, to direct < OFr. *adresser* < VLat. **addīrēctiāre*: Latin *ad-*, ad- + VLat. **dīrēctiāre*, to straighten (< Lat. *dīrēctus*, p.part. of *dīrigere*, to direct; see DIRECT).] —**ad·dress'er, ad·dres'sor** *n.*

**ad·dress·a·ble** (ə-drĕs'ə-bəl) *adj.* Accessible through an address, as in computer memory.

**ad·dress·ee** (ăd'rĕ-sē', ə-drĕs'ē') *n.* The one to whom something is addressed.

**ad·duce** (ə-do͞os', ə-dyo͞os') *tr.v.* **-duced, -duc·ing, -duc·es.** To cite as an example or means of proof in an argument. [Lat. *addūcere*, to bring to : *ad-*, ad- + *dūcere*, to lead; see **deuk-*.**] —**ad·duce'a·ble, ad·duc'i·ble** *adj.*

**ad·duct** (ə-dŭkt', ă-dŭkt') *tr.v.* **-duct·ed, -duct·ing, -ducts.** *Physiol.* To draw inward toward the median axis of the body or toward an adjacent part or limb. [Back-formation < ADDUCTOR.] —**ad·duc'tion** *n.* —**ad·duc'tive** *adj.*

**ad·duc·tor** (ə-dŭk'tər) *n.* A muscle that adducts a body part. [< Lat. *addūcere*, to bring to. See ADDUCE.]

**Ade** (ād), **George.** 1866–1944. Amer. humorist whose works include *Fables in Slang* (1899).

**-ade** *suff.* A sweetened beverage of: *limeade.* [ME < OFr., ult. < Lat. *-āta*, fem. of *-ātus*, -ate. See -ATE¹.]

**Ad·e·laide** (ăd'l-ād'). A city of S Australia NW of Melbourne; founded 1836. Met. area pop. 983,200.

**A·dé·lie Coast** also **A·dé·lie Land** (ə-dā'lē). A region of Antarctica near George V Coast, under French sovereignty.

**Adélie penguin** *n.* A common Antarctic penguin *(Pygoscelis adeliae)* that has white underparts and a black back and head.

**a·demp·tion** (ə-dĕmp'shən) *n. Law.* The disposal by a testator of property bequeathed in a will so as to invalidate the

adder's-tongue fern
*Ophioglossum vulgatum*

Adélie penguin
*Pygoscelis adeliae*

| | |
|---|---|
| ă pat | oi boy |
| ā pay | ou out |
| âr care | o͝o took |
| ä father | o͞o boot |
| ĕ pet | ŭ cut |
| ē be | ûr urge |
| ĭ pit | th thin |
| ī pie | *th* this |
| îr pier | hw which |
| ŏ pot | zh vision |
| ō toe | ə about, item |
| ô paw | |

Stress marks:
' (primary);
' (secondary), as in
dictionary (dĭk'shə-nĕr'ē)

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PATENT NUMBER: *6,684,513*
ISSUE DATE: *February 03, 2004*

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|---|---|---|---|
| Applicant | : Neville Sonnenberg et al. | Art Unit | : 3724 |
| Serial No. | : 09/515,421 | Examiner | : Hwei-Siu Payer |
| Filed | : February 29, 2000 | | |
| Title | : RAZOR BLADE TECHNOLOGY | | |

Commissioner for Patents
Washington, D.C. 20231

RESPONSE

In response to the action mailed May 25, 2001, please amend the application as follows:

In the specification:

Please amend the paragraph beginning at page 5, line 5 to read as follows:

B1

--Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes an interconnect member on which housing 116 is pivotally mounted at two arms 128. The interconnect member includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.--

In the claims:

Please cancel claim 3.

Please amend claims 1, 2, 21, 22, and 25 as follows:

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, Washington, D.C. 20231.

October 19, 2001
Date of Deposit

Jennifer Reveille
Signature

Jennifer Reveille
Typed or Printed Name of Person Signing Certificate

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B

B2

1. (Amended) A razor blade comprising a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

an overcoat layer of a chromium containing material on said layer of hard coating, and

an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. (Amended) The blade of claim 1 wherein said hard coating is made of amorphous carbon containing material.

Sub C3

B3

21. (Amended) A shaving razor comprising

a handle,

a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. (Amended) The razor of claim 21 wherein said hard coating is made of amorphous carbon containing material.

B4

25. (Amended) A method of making a razor blade comprising

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

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B4

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

B

REMARKS

The invention, as claimed in independent claims 1, 21 and 25, is directed to a razor blade having a substrate with a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of chromium containing material thereon, and an outer layer of polytetrafluoroethylene (PTFE) thereon. The claims have been amended to recite that the hard coating is made of "amorphous material," and, so limited, exclude crystalline material. Such amorphous material includes "diamond-like carbon" ("DLC"), as recited in dependent claim 4, and "amorphous diamond material," as recited in dependent claim 5. As noted at page 4, lines 2-4, with reference to the "Handbook of Physical Vapor Deposition (PVD) Processing," "DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond."

In the claimed invention, the use of an amorphous hard coating is advantageous in obtaining the desired tip geometry. When depositing a crystalline hard coating, the crystals can grow to a size that is larger than the desired tip radius, frustrating efforts to obtain a desired coating thickness and tip radius. This problem does not exist when depositing amorphous material, making it easier to deposit the desired amorphous hard coating thickness and obtain the desired tip radius shape. Such amorphous materials have been used extensively with a telomer (PTFE) outer coating, as described in the cited Hahn patent. A problem that has been noted with at least some amorphous carbon hard coating materials used with PTFE (in particular amorphous DLC), however, is that there is substantial rounding of the blade tips with repeated use during wet shaving, resulting in an increase in required cutting force during shaving.

The inventors found that, by using a chromium containing layer between an amorphous hard coating material and a PTFE layer, they could maintain the good edge strength provided by hard coating and have reduced tip rounding with repeated shaves. The razor blade has excellent shaving characteristics from the first shave onwards. These advantages are described in the application at page 2, line 27 to page 3, line 2. This is an unexpected result for the amorphous hard coating material, because it would not be expected that a material that is softer than the hard

coating, namely the chromium containing layer, would provide wear resistance and/or additional strength to the hard coating.

Independent claims 1, 21, and 25 stand rejected as anticipated by Lane U.S. Patent No. 3,911,579, which describes a blade having three layers deposited on a substrate, namely, refractory layer I, an adhesion promoting layer II containing chromium, and a PTFE layer III. The examples of refractory materials listed at col. 5, lines 56-64 are synthetic sapphire, corundum, glass, quartz, alumina, beryllia, silicon carbide, tungsten carbide and boron nitride. The Kirk Othmer, Concise Encyclopedia of Chemical Technology (John Wiley & Sons 1999), p. 1732 (copy enclosed) states that "refractory materials" are generally understood to withstand temperatures above 1100°C, a characteristic that is met by the examples of refractory materials listed in Lane.

Amorphous materials, on the other hand, will degrade at lower temperatures; e.g., the diamond like carbon and amorphous diamond amorphous materials noted above would deteriorate at temperatures above 400°C, which is substantially less than the 1100°C lower limit for refractory materials.

Lane accordingly does not anticipate or render obvious the independent claims, because it nowhere discloses or suggests a hard coating of an amorphous material. As noted above, the use of an amorphous material is advantageous in terms of obtaining a desired tip geometry without the problems associated with crystalline hard coatings.

The secondary references cited against dependent claims 4 and 5 for disclosure of amorphous diamond and diamond like carbon, namely, Hahn U.S. Patent No. 5,295,305 and Decker U.S. Patent No. 5,799,549, do not, taken with Lane, render the claims obvious. Both references teach away from the invention in teaching that a PTFE layer should be deposited directly on the amorphous hard coat carbon layer, which is the opposite of using a layer between them.

Moreover, none of the references teach the unexpected result of providing reduced tip rounding with repeated shaves, i.e., increased strength and wear resistance, by providing a softer, chromium containing layer outside of the amorphous hard coating layer. Accordingly, the subject matters of claims 1, 21, and 25 are nowhere suggested by the combination of cited references, and the independent claims are allowable under 35 USC 102 and 103(a).

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The remaining claims depend on the independent claims and are allowable with them.

Attached is a marked-up version of the changes being made by the current amendment.

Applicant asks that all claims be allowed. Enclosed is a $400 check for the Petition for Extension of Time fee. Please apply any other charges or credits to Deposit Account No. 06-1050.

Date: Oct 19, 2001

William E Booth
William E. Booth
Reg. No. 28,933

Fish & Richardson P.C.
225 Franklin Street
Boston, Massachusetts 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

20332754.doc

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**Version with markings to show changes made**

In the specification:

The paragraph beginning at page 5, line 5 has been amended as follows:

--Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes an interconnect member [124] on which housing 116 is pivotally mounted at two arms 128. The interconnect [Interconnect] member [124] includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.--

In the claims:

Claim 3 has been cancelled.

Claims 1, 2, 21, 22 and 25 have been amended as follows:

1. (Amended) A razor blade comprising

substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

an overcoat layer of a chromium containing material on said layer of hard coating, and

an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. (Amended) The blade of claim 1 wherein said hard coating is made of [a] amorphous carbon containing material.

21. (Amended) A shaving razor comprising

a handle,

B

a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising,

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. (Amended) The razor of claim 21 wherein said hard coating is made of [a] amorphous carbon containing material.

25. (Amended) A method of making a razor blade comprising

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge, said hard coating being made of amorphous material,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

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cn

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# NOTICE OF ALLOWANCE AND FEE(S) DUE

26161 7590 09/24/2003

FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

| EXAMINER | |
|---|---|
| PAYER, HWEI SIU CHOU | |
| ART UNIT | CLASS-SUBCLASS |
| 3724 | 030-346540 |

DATE MAILED: 09/24/2003

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/515,421 | 02/29/2000 | Colin John Clipstone | 00216-483001 | 1454 |

TITLE OF INVENTION: RAZOR BLADE TECHNOLOGY

| APPLN. TYPE | SMALL ENTITY | ISSUE FEE | PUBLICATION FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|
| nonprovisional | NO | $1300 | $0 | $1300 | 12/24/2003 |

**THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.**

**THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.**

**HOW TO REPLY TO THIS NOTICE:**

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

**IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.**



PTOL-85 (Rev. 08/03) Approved for use through 04/30/2004.

GILLETTE-DSC-0220848

## PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail** **Mail Stop ISSUE FEE**
**Commissioner for Patents**
**Alexandria, Virginia 22313-1450**
**or Fax (703) 746-4000**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

26161 7590 09/24/2003

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225 FRANKLIN ST
BOSTON, MA 02110

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

**Certificate of Mailing or Transmission**

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/515,421 | 02/29/2000 | Colin John Clipstone | 00216-483001 | 1454 |

TITLE OF INVENTION: RAZOR BLADE TECHNOLOGY

| APPLN. TYPE | SMALL ENTITY | ISSUE FEE | PUBLICATION FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|
| nonprovisional | NO | $1300 | $0 | $1300 | 12/24/2003 |

| EXAMINER | ART UNIT | CLASS-SUBCLASS |
|---|---|---|
| PAYER, HWEI SIU CHOU | 3724 | 030-346540 |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 ____________________

2 ____________________

3 ____________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent); ❑ individual ❑ corporation or other private group entity ❑ government

4a. The following fee(s) are enclosed:

❑ Issue Fee

❑ Publication Fee

❑ Advance Order - # of Copies ____________

4b. Payment of Fee(s):

❑ A check in the amount of the fee(s) is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number ____________ (enclose an extra copy of this form).

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) (Date)

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/515,421 | 02/29/2000 | Colin John Clipstone | 00216-483001 | 1454 |

26161 7590 09/24/2003

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BOSTON, MA 02110

| EXAMINER | |
|---|---|
| PAYER, HWEI SIU CHOU | |
| **ART UNIT** | **PAPER NUMBER** |
| 3724 | 23 |

DATE MAILED: 09/24/2003

**Determination of Patent Term Extension under 35 U.S.C. 154 (b)**
(application filed after June 7, 1995 but prior to May 29, 2000)

The Patent Term Extension is 0 day(s). Any patent to issue from the above-identified application will include an indication of the 0 day extension on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Extension is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.



PTOL-85 (Rev. 08/03) Approved for use through 04/30/2004.

GILLETTE-DSC-0220850

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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/515,421 | 02/29/2000 | Colin John Clipstone | 00216-483001 | 1454 |

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BOSTON, MA 02110

| EXAMINER | |
|---|---|
| PAYER, HWEI SIU CHOU | |
| ART UNIT | PAPER NUMBER |
| 3724 | |

DATE MAILED: 09/24/2003

## Notice of Fee Increase on October 1, 2003

If a reply to a "Notice of Allowance and Fee(s) Due" is filed in the Office on or after October 1, 2003, then the amount due will be higher than that set forth in the "Notice of Allowance and Fee(s) Due" since there will be an increase in fees effective on October 1, 2003. See Revision of Patent Fees for Fiscal Year 2004; Final Rule, 68 Fed. Reg. 41532, 41533, 41534 (July 14, 2003).

The current fee schedule is accessible from (http://www.uspto.gov/main/howtofees.htm).

If the fee paid is the amount shown on the "Notice of Allowance and Fee(s) Due" but not the correct amount in view of the fee increase, a "Notice of Pay Balance of Issue Fee" will be mailed to applicant. In order to avoid processing delays associated with mailing of a "Notice of Pay Balance of Issue Fee," if the response to the Notice of Allowance is to be filed on or after October 1, 2003 (or mailed with a certificate of mailing on or after October 1, 2003), the issue fee paid should be the fee that is required at the time the fee is paid. If the issue fee was previously paid, and the response to the "Notice of Allowance and Fee(s) Due" includes a request to apply a previously-paid issue fee to the issue fee now due, then the difference between the issue fee amount at the time the response is filed and the previously-paid issue fee should be paid. See Manual of Patent Examining Procedure, Section 1308.01 (Eighth Edition, August 2001).

Effective October 1, 2003, 37 CFR 1.18 is amended by revising paragraphs (a) through (c) to read as set forth below.

Section 1.18 Patent post allowance (including issue) fees.

(a) Issue fee for issuing each original or reissue patent, except a design or plant patent:
By a small entity (Sec. 1.27(a))...................... $665.00
By other than a small entity......................... $1,330.00

(b) Issue fee for issuing a design patent:
By a small entity (Sec. 1.27(a))...................... $240.00
By other than a small entity............................ $480.00

(c) Issue fee for issuing a plant patent:
By a small entity (Sec. 1.27(a))...................... $320.00
By other than a small entity............................ $640.00

Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

| Notice of Allowability | Application No. 09/515,421 | Applicant(s) CLIPSTONE ET AL. | |
|---|---|---|---|
| | Examiner Hwei-Siu C. Payer | Art Unit 3724 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--*

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed on 8-6-2003*.
2. ☒ The allowed claim(s) is/are *1,4-21,23-28 and 31-43*.
3. ☐ The drawings filed on ____ are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. ____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: ____.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
   (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

8. ☒ CORRECTED DRAWINGS must be submitted.
   (a) ☒ including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached
   1) ☒ hereto or 2) ☐ to Paper No. ____.
   (b) ☐ including changes required by the proposed drawing correction filed ____, which has been approved by the Examiner.
   (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. ____.

**Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet.**

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

1☐ Notice of References Cited (PTO-892)
3☒ Notice of Draftperson's Patent Drawing Review (PTO-948)
5☐ Information Disclosure Statements (PTO-1449), Paper No. ____.
7☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
2☐ Notice of Informal Patent Application (PTO-152)
4☒ Interview Summary (PTO-413), Paper No. 23 .
6☒ Examiner's Amendment/Comment
8☐ Examiner's Statement of Reasons for Allowance
9☐ Other

H-S. Payer

Hwei-Siu Payer
Primary Examiner



9/23/03

GILLETTE-DSC-0220852

**Examiner's Amendment**

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

(second occurrence)

1sp (1) In claim 31, line 5, "a" has been changed to --the--.

(second occurrence)

1sp (2) In claim 38, line 8, "a" has been changed to --the--.

(3) In claim 40, line 1, "38" has been changed to --39--.

2. Authorization for this examiner's amendment was given in a telephone interview with Mr. William Booth on September 23, 2003.

**Point of Contact**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hwei-Siu C. Payer whose telephone number is 703-308-1405. The examiner can normally be reached on Monday through Friday, 7:00 am to 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Allan N. Shoap can be reached on 703-308-1082. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9302 for official communications and 703-746-3293 for proposed amendments.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-1148.

H-S. Payer

H Payer
September 23, 2003

Hwei-Siu Payer
Primary Examiner

# Exhibit 13

JC712 U.S. PTO
09/515421
02/29/00

| Class | Subclass |
|---|---|
| 030 | 346.54 |

ISSUE CLASSIFICATION

RB

PATENT NUMBER
6684513
6684513

U.S. **UTILITY** Patent Application

| O.I.P.E. SCANNED HA Q.A. | PATENT DATE FEB 03 2004 |
|---|---|

| APPLICATION NO. | CONT/PRIOR | CLASS | SUBCLASS | ART UNIT | EXAMINER |
|---|---|---|---|---|---|
| 09/515421 | | 030 | 346.54 | 3724 | Payer |

APPLICANTS
Colin Clipstone
Steve Hahn
Neville Sonnenberg
Charles White

TITLE
Razor Blade technology

Certificate
NOV 09 2004
of Correction

PTO-2040
12/99

## ISSUING CLASSIFICATION

| ORIGINAL | | CROSS REFERENCE(S) | | | | | |
|---|---|---|---|---|---|---|---|
| CLASS | SUBCLASS | CLASS | SUBCLASS (ONE SUBCLASS PER BLOCK) | | | | |
| 030 | 346.54 | 030 | 346.53 | | | | |
| INTERNATIONAL CLASSIFICATION | | | | | | | |
| B26B 21/58 | | | | | | | |
| B26B 21/60 | | | | | | | |
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| TERMINAL DISCLAIMER | DRAWINGS | | | CLAIMS ALLOWED | |
|---|---|---|---|---|---|
| | Sheets Drwg. | Figs. Drwg. | Print Fig. | Total Claims | Print Claim for O.G. |
| | 1 | 2 | 1 | 38 | 20 |
| The term of this patent subsequent to ______ (date) has been disclaimed. | (Assistant Examiner) | | (Date) | NOTICE OF ALLOWANCE MAILED | |
| The term of this patent shall not extend beyond the expiration date of U.S Patent. No. ______ | Hwei-Siu Payer Primary Examiner (Primary Examiner) | | 9/23/03 (Date) | 9/24/3 | |
| | | | | ISSUE FEE 1W | |
| | | | | Amount Due | Date Paid |
| | | | | 1330 | 11-28-03 |
| The terminal ____months of this patent have been disclaimed. | (Legal Instruments Examiner) | | 9/3/03 (Date) | ISSUE BATCH NUMBER | |

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ISSUE FEE IN FILE

(FACE)

PATENT APPLICATION

09515421

jc712 U.S. PTO
09/515421
02/29/00

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| | | Date Received (Incl. C. of M.) or Date Mailed | | | Date Received (Incl. C. of M.) or Date Mailed |
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| 1. | Application papers. | | 42. | | |
| 2. | Ltr RE unsigned Decl | 4-28-00 | 43. | | |
| 2a | Amdt | 8-2-00 | | | |
| 3. | Decl, ext fee | 8-2-00 | 44. | | |
| 4. | IDS | 7-17-00 | 45. | | |
| 5. | Rej (3) | 5-25-01 | 46. | | |
| 6. | Suppl IDS | 9-4-01 | 47. | | |
| 7. | Req for Ext (2) | 1-7-02 | 48. | | |
| 8. | Amdt B w/ attach | 1-7-02 | 49. | | |
| 9. | Rej (3) | 2/5/02 | 50. | | |
| 10. | I.D.S. | 2/27/02 | 51. | | |
| 11. | Misc Ltr Re IDS | 3/18/02 | 52. | | |
| 12. | Req for Ext (2) | 6-14-02 | 53. | | |
| 13. | Amdt C | 6-14-02 | 54. | | |
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| 15. | Req for Ext (2) | 1-13-03 | 56. | | |
| 16. | [illegible] | 1-13-03 | 57. | | |
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| 19. | Change of Add. | 3/24/03 | 60. | | |
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PATENT APPLICATION SERIAL NO. ______________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

'3/08/2000 DBUTLER 00000022 09515421

':101 690.00 OP
'03 306.00 OP
'4 260.00 OP

Repln. Ref: 03/08/2000 DBUTLER 0012380300
DA#:061050 Name/Number:09515421
FC: 704 $78.00 CR

PTO-1556
(5/87)

*U.S. GPO: 1999-459-082/19144

UNITED STATES PATENT AND TRADEMARK OFFICE

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Bib Data Sheet

| SERIAL NUMBER | FILING DATE | CLASS | GROUP ART UNIT | ATTORNEY DOCKET NO. |
|---|---|---|---|---|
| 09/515,421 | 02/29/2000<br>RULE – | 030 | 3724 | 00216-483001 |

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** CONTINUING DATA ************************** no

** FOREIGN APPLICATIONS ******************** no

**IF REQUIRED, FOREIGN FILING LICENSE GRANTED** ** 04/27/2000

| | STATE OR COUNTRY | SHEETS DRAWING | TOTAL CLAIMS | INDEPENDENT CLAIMS |
|---|---|---|---|---|
| Foreign Priority claimed ☐ yes ☒ no<br>35 USC 119 (a-d) conditions met ☐ yes ☒ no ☐ Met after Allowance<br>Verified and Acknowledged ______ Examiner's Signature ______ Initials | MA | 1 | 34 | 3 |

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**TITLE**

Razor Blade technology

| FILING FEE RECEIVED | | |
|---|---|---|
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jc712 U.S. PTO 09/515421 02/29/00

jc781 U.S. PTO 02/29/00

February 29, 2000

Attorney Docket No.: 00216-483001

**Box Patent Application**
Assistant Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicant: NEVILLE SONNENBERG, ANDREW ZHUK, CHARLES WHITE, STEVEN HAHN AND COLIN CLIPSTONE

Title: RAZOR BLADE TECHNOLOGY

Enclosed are the following papers, including those required to receive a filing date under 37 CFR 1.53(b):

| | Pages |
|---|---|
| Specification | 5 |
| Claims | 4 |
| Abstract | 1 |
| Declaration | [To be Filed at a Later Date] |
| Drawing(s) | 1 |

Enclosures:
— Postcard.

| | |
|---|---|
| Basic filing fee | $690 |
| Total claims in excess of 20 times $18 | $306 |
| Independent claims in excess of 3 times $78 | $78 |
| Fee for multiple dependent claims | $260 |
| Total filing fee: | $1334 |

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Respectfully submitted,

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Enclosures
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20032209.doc

Attorney's Docket No.: 00216-483001 / Case 8073

Jc712 U.S. PTO
09/515421
02/29/00

# APPLICATION

# FOR

# UNITED STATES LETTERS PATENT

TITLE: RAZOR BLADE TECHNOLOGY

APPLICANT: NEVILLE SONNENBERG, ANDREW ZHUK, CHARLES WHITE, STEVEN HAHN AND COLIN CLIPSTONE

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Signature

Samantha Bell
Typed or Printed Name of Person Signing Certificate

Attorney Docket No. 00216-483001

## Razor Blade Technology

The invention relates to improvements to razors and razor blades.

A razor blade is typically formed of a suitable substrate material such as stainless steel, and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius less than about 1000 angstroms, e.g., about 200 - 300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting thinner edges with lower cutting forces to be used. Polytetrafluoroethylene (PTFE) outer layer can be used to provide friction reduction. Interlayers of niobium or chromium containing materials can aid in improving the binding between the substrate, typically stainless steel, and hard carbon coatings, such as DLC. Examples of razor blade cutting edge structures and processes of manufacture are described in U.S. Patents Nos. 5,295,305; 5,232,568; 4,933,058; 5,032,243; 5,497,550; 5,940,975; 5,669,144; EP 0591339; and PCT 92/03330, which are hereby incorporated by reference.

In use, the ultimate tip of the edges having hard coatings and polytetrafluoroethylene outer layers can become more rounded after repeated shaves such that there is an increase in the tip radius and a generally perceived decrease in shaving performance.

### Summary of the Invention

In one aspect, the invention features, in general, a razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene coating on the overcoat layer.

In another aspect the invention features, in general, a shaving razor including a handle and a razor head with a blade having a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard coating, and an outer layer of polytetrafluoroethylene

coating on the overcoat layer.

Particular embodiments of the invention may include one or more of the following features. In particular embodiments, the hard coating material can be made of carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides, carbides, oxides or other ceramics. The hard coating layer can have a thickness less than 2,000 angstroms. The overcoat layer can be made of chromium or a chromium containing alloy compatible with polytetrafluoroethylene such as a chromium platinum alloy. The overcoat layer can be between 100 and 500 angstroms thick. The blade can include an interlayer between the substrate and the layer of hard coating. The interlayer can include niobium or a chromium containing material. The polytetrafluoroethylene can be Krytox LW1200 available from DuPont. The PTFE outer layer can be between 100 and 5000 angstroms thick.

In another aspect, the invention features, in general, making a razor blade by providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets, adding a layer of hard coating on the cutting edge, adding an overcoat layer of a chromium containing material on the layer of hard coating, and adding an outer layer of polytetrafluoroethylene coating over the overcoat layer.

Particular embodiments of the invention may include one or more of the following features. In particular embodiments the layers can be added by physical vapor deposition (i.e., sputtering) or by chemical vapor deposition. The chromium containing layer, preferably chromium, can be sputter deposited under conditions that result in a compressively stressed coating. The sputter deposition of chromium containing materials can include applying a DC bias to the target that is more negative than -50 volts, preferably more negative than -200 volts. Alternatively an appropriate RF bias scheme can be used to achieve an equivalent chromium layer.

Embodiments of the invention may include one or more of the following advantages. The use of a chromium containing overcoat layer provides improved adhesion of the polytetrafluorethylene outer layer to the hard coating layer. The razor blade has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves. Reduced

tip rounding minimizes the increase in cutting force thereby maintaining excellent shaving performance. The razor blade has excellent shaving characteristics from the first shave onwards.

Other features and advantages of the invention will be apparent from the following description of a particular embodiment and from the claims.

## Description of the Drawings

FIG. 1 is a vertical sectional view of a cutting edge portion of a razor blade.

FIG.2 is a perspective view of a shaving razor including the FIG. 1 razor blade.

## Description of a Particular Embodiment

Referring to FIG. 1, there is shown razor blade 10 including substrate 12, interlayer 14, hard coating layer 16, overcoat layer 18, and outer layer 20. The substrate 12 is typically made of stainless steel (though other substrates can be employed) and has an ultimate edge sharpened to a tip radius of less than 1,000 angstroms, preferably 200 to 300 angstroms, and has a profile with side facets 22 at an included angle of between 15 and 30 degrees, preferably about 19 degrees, measured at 40 microns from the tip.

Interlayer 14 is used to facilitate bonding of the hard coating layer to the substrate. Examples of suitable interlayer material are niobium and chromium containing material. A particular interlayer is made of niobium greater than 100 angstroms and preferably less than 500 angstroms thick. PCT 92/03330 describes use of a niobium interlayer.

Hard coating layer 16 provides improved strength, corrosion resistance and shaving ability and can be made from carbon containing materials (e.g., diamond, amorphous diamond or DLC), nitrides (e.g., boron nitride, niobium nitride or titanium nitride), carbides (e.g., silicon carbide), oxides (e.g., alumina, zirconia) or other ceramic materials. The carbon containing materials can be doped with other elements, such as tungsten, titanium or chromium by including these additives , for example in the target during application by sputtering. The materials can also incorporate hydrogen, e.g., hydrogenated DLC. Preferably coating layer 16 is made of diamond, amorphous diamond or DLC. A particular embodiment includes DLC less than 2,000



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angstroms, preferably less than 1,000 angstroms. DLC layers and methods of deposition are described in U.S. Patent No. 5,232,568. As described in the "Handbook of Physical Vapor Deposition (PVD) Processing," DLC is an amorphous carbon material that exhibits many of the desirable properties of diamond but does not have the crystalline structure of diamond.

Overcoat layer 18 is used to reduce the tip rounding of the hard coated edge and to facilitate bonding of the outer layer to the hard coating while still maintaining the benefits of both. Overcoat layer 18 is preferably made of chromium containing material, e.g., chromium or chromium alloys that are compatible with polytetrafluoroethylene, e.g., CrPt. A particular overcoat layer is chromium about 100-200 angstroms thick. Blade 10 has a cutting edge that has less rounding with repeated shaves than it would have without the overcoat layer.

Outer layer 20 is used to provide reduced friction and includes polytetrafluoroethylene and is sometimes referred to as a telomer. A particular polytetrafluoroethylene material is Krytox LW 1200 available from DuPont. This material is a nonflammable and stable dry lubricant that consists of small particles that yield stable dispersions. It is furnished as an aqueous dispersion of 20% solids by weight and can be applied by dipping, spraying, or brushing, and can thereafter be air dried or melt coated. The layer is preferably less than 5,000 angstroms and could typically be 1,500 angstroms to 4,000 angstroms, and can be as thin as 100 angstroms, provided that a continuous coating is maintained. Provided that a continuous coating is achieved, reduced telomer coating thickness can provide improved first shave results. U.S. Patents Nos. 5,263,256 and 5,985,459, which are hereby incorporated by reference, describe techniques which can be used to reduce the thickness of an applied telomer layer.

Razor blade 10 is made generally according to the processes described in the above referenced patents. A particular embodiment includes a niobium interlayer14, DLC hard coating layer 16, chromium overcoat layer 18, and Krytox LW1200 polytetrafluoroethylene outer coat layer 20. Chromium overcoat layer 18 is deposited to a minimum of 100 angstroms and a maximum of 500 angstroms. It is deposited by sputtering using a DC bias (more negative than -50 volts and preferably more negative than -200 volts) and pressure of about 2 millitorr argon. The increased negative bias is believed to promote a compressive stress (as opposed to a tensile

stress), in the chromium overcoat layer which is believed to promote improved resistance to tip rounding while maintaining good shaving performance. Blade 10 preferably has a tip radius of about 200- 400 angstroms, measured by SEM after application of overcoat layer 18 and before adding outer layer 20.

mB17

Referring to FIG. 2, blade 10 can be used in shaving razor 110, which includes handle 112 and replaceable shaving cartridge 114. Cartridge 14 includes housing 116, which carries three blades 10, guard 120 and cap 122. Blades 10 are movably mounted, as described, e.g., in U.S. Patent No. 5,918,369, which is incorporated by reference. Cartridge 114 also includes interconnect member 124 on which housing 116 is pivotally mounted at two arms 128. Interconnect member 124 includes a base 127 which is replaceably connected to handle 112. Alternatively, blade 10 can be used in other razors having one, two or more than three blades, double-sided blades, and razors that do not have movable blades or pivoting heads where the cartridge is either replaceable or permanently attached to a razor handle.

In use, razor blade 10 has excellent shaving characteristics from the first shave onwards. Blade 10 has improved edge strength provided by hard coating and has reduced tip rounding with repeated shaves provided by the overlayer coating while maintaining excellent shave characteristics.

Other embodiments of the invention are within the scope of the appended claims.

What is claimed is:



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Sub B1

1. A razor blade comprising
a substrate with a cutting edge defined by a sharpened tip and adjacent facets,
a layer of hard coating on said cutting edge,
an overcoat layer of a chromium containing material on said layer of hard coating, and
an outer layer of polytetrafluoroethylene coating over said overcoat layer.

2. The blade of claim 1 wherein said hard coating is made of a carbon containing material.

3. The blade of claim 2 wherein said carbon containing material comprises diamond.

4. The blade of claim 2 wherein said hard carbon coating comprises diamond-like carbon material.

5. The blade of claim 2 wherein said hard carbon coating comprises amorphous diamond material.

6. The blade of claim 1 wherein said overcoat layer consists of chromium.

7. The blade of claim 1 wherein said overcoat layer consists of a chromium containing alloy compatible with polytetrafluoroethylene.

8. The blade of claim 4 wherein said overcoat layer consists of chromium.

9. The blade of claim 7 wherein said alloy is a chromium platinum alloy.

Sub C1

10. The blade of claim 1 further comprising an interlayer between said substrate and said layer of

hard carbon coating.

11. The blade of claim 10 wherein said interlayer comprises niobium.

12. The blade of claim 10 wherein said interlayer comprises a chromium containing material.

13. The blade of claim 6, 7, 8, or 9 wherein said overcoat layer is compressively stressed.

14. The blade of claim 1 wherein said polytetrafluoroethylene is Krytox LW1200.

15. The blade of claim 4 further comprising a niobium interlayer between said substrate and said hard coating.

16. The blade of claim 8 wherein said polytetrafluoroethylene is Krytox LW1200.

17. The blade of claim 1 wherein said hard coating layer has a thickness less than 2,000 angstroms.

18. The blade of claim 1 wherein said overcoat layer is between 100 and 500 angstroms thick.

19. The blade of claim 1 wherein said outer layer is between 100 and 5,000 angstroms thick.

20. The blade of claim1, 8, 16 or 17 wherein said blade has a cutting edge that has less rounding with repeated shaves than it would have without said overcoat layer.

21. A shaving razor comprising
a handle,
a housing connected to said handle, and

at least one razor blade mounted in said housing, said blade comprising

a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

a layer of hard coating on said cutting edge,

an overcoat layer of a chromium containing material on said layer of hard coating, and

a outer layer of polytetrafluoroethylene coating over said overcoat layer.

22. The razor of claim 21 wherein said hard coating is made of a carbon containing material.

23. The razor of claim 22 further comprising a niobium interlayer between said substrate and said hard coating.

24. The razor of claim 21 or 22 wherein said overcoat layer consists of chromium.

25. A method of making a razor blade comprising

providing a substrate with a cutting edge defined by a sharpened tip and adjacent facets,

adding a layer of hard coating on said cutting edge,

adding an overcoat layer of a chromium containing material on said layer of hard coating, and

adding an outer layer of polytetrafluoroethylene coating over said overcoat layer.

26. The method of claim 25 wherein said adding a layer of hard coating includes vapor depositing a carbon containing material.

27. The method of claim 25 wherein said adding a layer of chromium containing material includes vapor depositing said chromium containing material.

28. The method of claim 27 wherein said adding a layer of chromium containing material includes sputter depositing under conditions to result in compressively stressed material.

29. The method of claim 28 wherein said sputtering includes applying a DC bias to said target that is more negative than -50 volts or an equivalent RF bias scheme.

30. The method of claim 28 wherein said sputtering includes applying a DC bias to said target that is more negative than -200 volts or an equivalent RF bias scheme.

Attorney Docket No. 00216-483001

Abstract of the Disclosure

A razor blade including a substrate with a cutting edge defined by a sharpened tip and adjacent facets, a layer of hard coating on the cutting edge, an overcoat layer of a chromium containing material on the layer of hard carbon coating, and an outer layer of polytetrafluoroethylene coating over the overcoat layer.

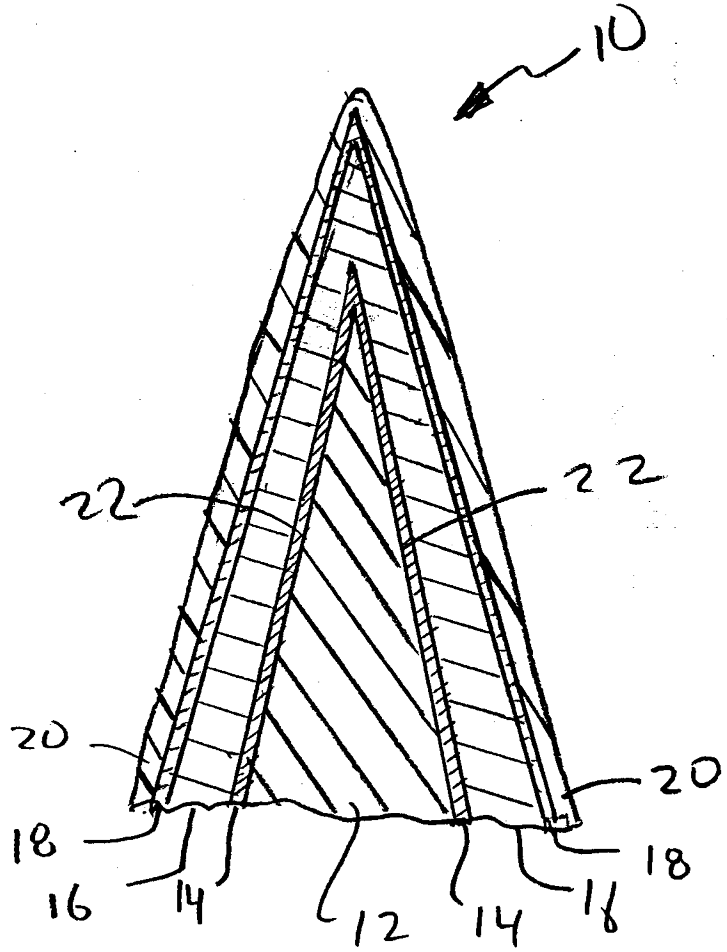


FIG. 1

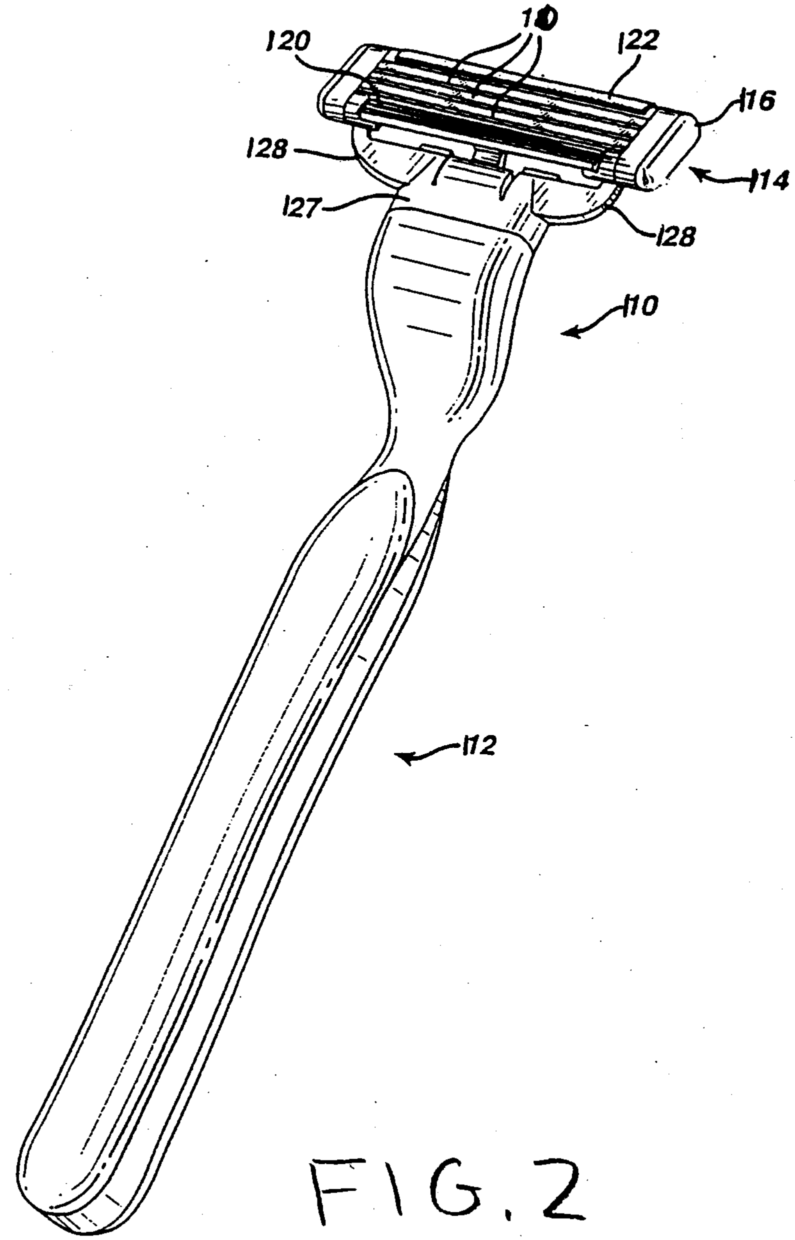


FIG. 2

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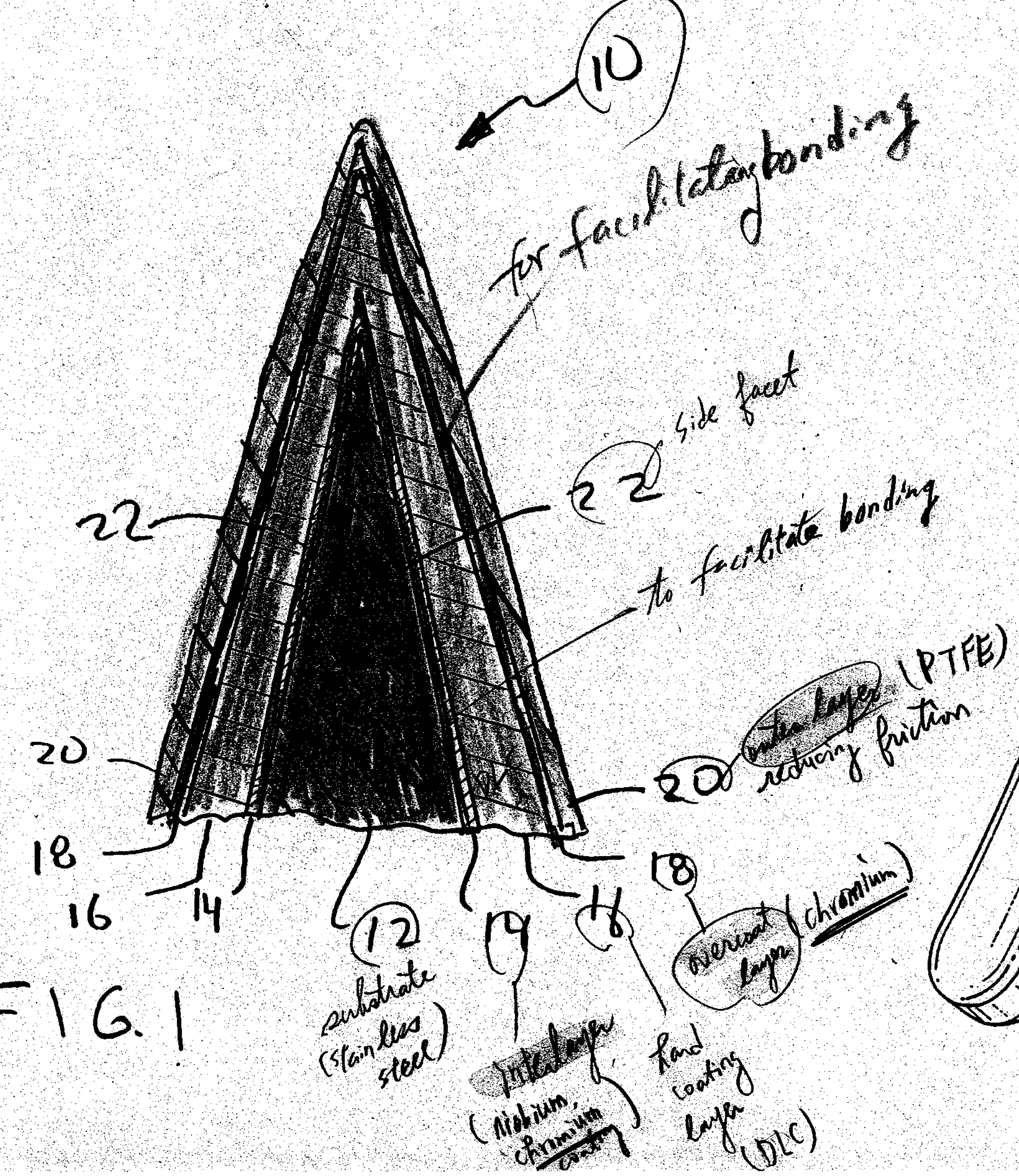


FIG. 1

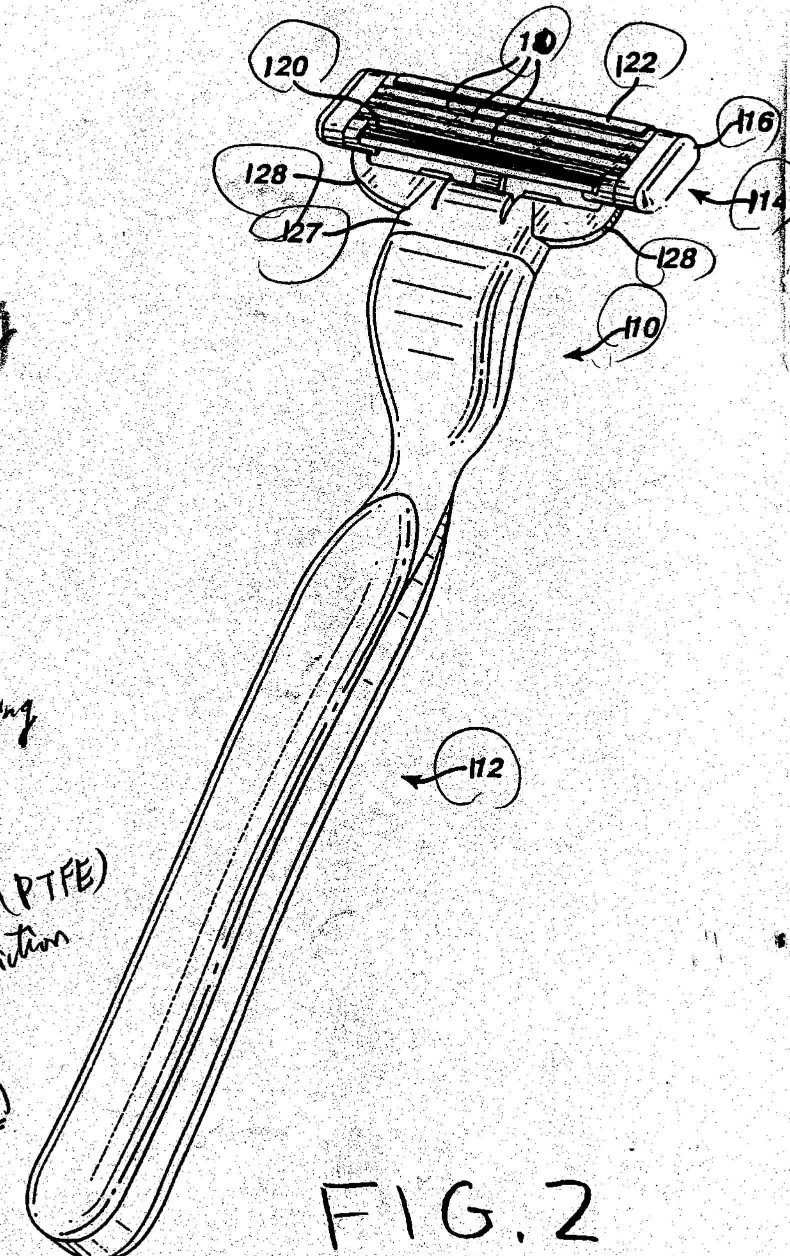


FIG. 2

Attor. Docket No.: 00216-483001
Client's Ref. No.: Case 8073

# COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled RAZOR BLADE TECHNOLOGY, the specification of which:

[X] is attached hereto.
[] was filed on _ as Application Serial No. _ and was amended on _______________.
[] was described and claimed in PCT International Application No. _______________ filed on _______________ and as amended under PCT Article 19 on _______________.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim the benefit under Title 35, United States Code, §119(e)(1) of any United States provisional application(s) listed below:

| U.S. Serial No. | Filing Date | Status |
| --- | --- | --- |

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose all information I know to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

| U.S. Serial No. | Filing Date | Status |
| --- | --- | --- |

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

| Country | Application No. | Filing Date | Priority Claimed |
| --- | --- | --- | --- |

Attor Docket No.: 00216-483001
Client's Ref. No.: Case 8073

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

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Inventor's Signature: ______________________________ Date: ______________
Residence Address:
Citizenship:
Post Office Address:

Full Name of Inventor: Andrew Zhuk

Inventor's Signature: ______________________________ Date: ______________
Residence Address:
Citizenship:
Post Office Address:

Full Name of Inventor: Charles White

Inventor's Signature: ______________________________ Date: ______________
Residence Address:
Citizenship:
Post Office Address:

Attor Docket No.: 00216-483001
Client's Ref. No.: Case 8073

# Combined Declaration and Power of Attorney

Page 3 of 3 Pages

Full Name of Inventor: Steven Hahn

Inventor's Signature: ______________________ Date: ____________
Residence Address:
Citizenship:
Post Office Address:

Full Name of Inventor: Colin Clipstone

Inventor's Signature: ______________________ Date: ____________
Residence Address:
Citizenship:
Post Office Address:

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